ROADS AND STREETS

Design, Construction, Maintenance and Traffic Control

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***See the Road and Street Catalog & Data Book**

In addition to the advertising messages to be found in this issue of Roads and Streets on the pages as indicated above, condensed catalogs of those marked * as well as other specifications and construction data will be found in the Road and Street Catalog and Data Book, the 384 page annual reference guide for the highway industries, published by the Gillette Publishing Co.

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ROADS AND STREETS
A Gillette Publication—Established 1906

Vol. LXXI Chicago, June, 1931 No. 6

Worn Condition of Old Paving; Also Concrete Resurfacing Open to Traffic

RESURFACING *with* CONCRETE *on an Old Concrete Base*

How a rough and badly-worn wood-block surface in the borough of Richmond, New York City, was replaced with a 4-in. reinforced concrete pavement

By THOMAS B. OAKLEY
Borough Engineer, Borough of Richmond, New York, N. Y.

THE wood-block surface of Richmond Terrace, St. George, Staten Island, had become worn, rough and badly in need of repair. Late in 1930 this was replaced with a reinforced concrete surface having a minimum thickness of 4 in. Richmond Terrace serves much heavy trucking to the ferries and the boroughs of Manhattan and Brooklyn, in addition to the abnormally heavy traffic it receives due to its central location in this metropolitan area. In replacing the rough, worn surface it was desirable to provide for future traffic increases, as well as present needs.

Reinforced Concrete Selected.—After thorough study of the problem it was decided to use reinforced concrete resurfacing. An inspection showed that the old concrete base, placed in 1913, a 6-in., 1:3:6 mix, was in good condition. To provide an improvement adequate for the many years this street must serve constantly increasing demands, a minimum thickness of 4 in. of 1:2:3½ concrete with not to exceed 5½ gal. of water per sack of cement and 70 to 75 lb. of wire-mesh reinforcement per 100 sq. ft. was used over the old base. All corners of slabs were reinforced with ¾-in. corner bars bent at right angles 4 ft. on each leg.

Parking Space Provided.—To increase the roadway a 7-ft. widening strip 6 in. thick was added for parking purposes on the north side of the street. This pro-

vides parking space for about 180 automobiles without obstruction to the free flow of traffic. Half-inch premolded transverse expansion joints were spaced 40 ft. apart and longitudinal joints were placed at the curbs, at the outer edge of the 2-ft. trolley strips and in the center of the trolley dummy strip. The maximum width of pavement strip was 10 ft.

The importance of this street made it necessary to maintain traffic during construction. To accomplish this with the least inconvenience to traffic, half of the street was paved at a time and high-early-strength concrete was used. Clean and coarse sand with less than 5 per cent clay, all to pass a No. 4 sieve, was used; "Cedarcliffe" dolomite was used for the coarse aggregate.

The unit-cost of the work included in the contract was as follows:

Concrete in resurfacing, cu. yd.	$13.30
Reinforcement, sq. ft.	0.025
Replacing of concrete foundation, cu. yd.	8.00

Removal and disposal of the old wood-block surface, old mortar bed and condemned concrete foundation was included in these unit-prices.

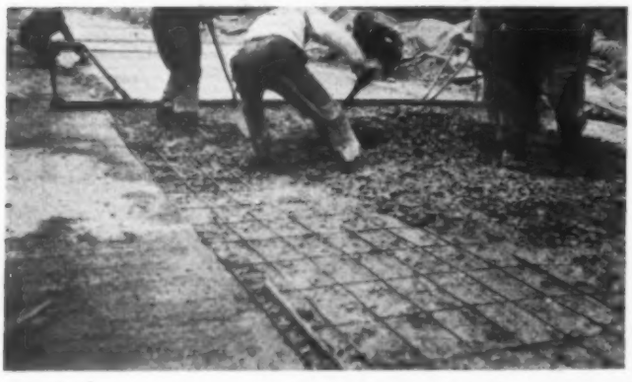
The contract called for resurfacing the total width of the roadway, 60 and 67 ft. in width, and a length of 1,579.8 lin. ft., involving a total area of 11,639 sq. yd. Work was started Oct. 6, 1930, and completed Jan. 12, 1931. The contract was executed by the Vanbro Construction Corp., of Staten Island.

An inspection of the concrete resurfacing after the first winter's use and all freezing weather was over shows that the pavement is very satisfactory.

Specifications for the Improvement.—The following are extracts from the specifications:

1. *Scope of Work:* The work under this contract will

Left—Progress of Resurfacing. Left-Hand Car Track Completed First, Followed by Outer Strip, 7 Ft. Wide. Excellent Condition of Old Concrete Base Is Apparent. Right—Finishing Center Strip. This Strip Placed Last. Same Operations Repeated on Other Side After This Section Was Opened to Traffic



Left—Spreading Concrete; Note Consistency. Right—Completed Street Intersection in Front of Borough Hall

Left—Cars Parked on Widening Strip of Finished Resurfacing. Upper New York Bay and Freight Terminal Facilities in Background. Right—Intersection of Richmond Terrace and Approach to St. George Terminal Ferry Slips

consist of the following: The present curb will be reset to the new lines and grades, as shown on the plan or as directed by the engineer. The present pavement and mortar bed will be removed without injury to the present concrete foundation. The present concrete foundation, where unsuitable, will be removed to the extent deemed necessary by the engineer, and the subgrade brought to a firm and uniform surface. The present concrete foundation will be thoroughly cleaned and flushed with water immediately prior to laying the new concrete pavement. The new concrete pavement will be placed on the old concrete foundation or subgrade prepared as described. The depth of the new pavement will vary but will be sufficient to bring the finished surface to the grade and crown shown on the typical section, or as directed by the engineer. The pavement will be laid in lanes and panels as indicated on the typical section and as directed by the engineer. The street will be kept open to two-way vehicular and trolley traffic at all times.

2. The transverse expansion joints shall be spaced about 40 ft. apart, and extend from the top of the finished pavement to the top of the existing concrete foundation, excepting that at every fourth expansion joint, or about every 120 ft., the joint shall extend from the top of the finished pavement to the bottom of the existing concrete foundation. This shall be done by removing the existing concrete foundation for a width of 1½ ft. on each side of the joint; the space originally occupied by this concrete foundation will be filled with pavement concrete as the paving slabs are poured, as indicated on plan. Short spacing shall be used as directed by the engineer. Expansion joints in adjoining slabs shall be directly opposite each other.

3. Longitudinal expansion joints shall be placed along the face of the curbs 2 ft. outside of the outer rails of the trolley tracks and parallel thereto, and in the center of the dummy strip (between the tracks) and parallel to the rails; except that when the trolley tracks are separated by more than 8 ft. as at curves, an expansion joint shall be placed 2 ft. away from the inner rails of the track and parallel thereto. The longitudinal expansion joint shall be set flush with the finished surface, and its depth shall be equal to the depth of the new concrete pavement.

4. Expansion-joint filler shall consist of sheets of bituminous felt or prepared semi-solid bitumen ½ in. thick. The ductile and penetration properties of the filler shall be satisfactory to the engineer.

The design and construction of this work were done under the supervision of Thomas B. Oakley, borough engineer; Wm. B. Grubbe, construction engineer, and Daniel F. Haley, division engineer. John A. Lynch is borough president.

▼

Highway Accounting Problems in Arizona

Accounting for the large sums of money used in the maintenance and construction of Arizona's 2,600 miles of highways is an interesting and important part of the activities of the state highway department, according to R. L. Jones, chief accountant, who contributes the following account of this work in *Arizona Highways*.

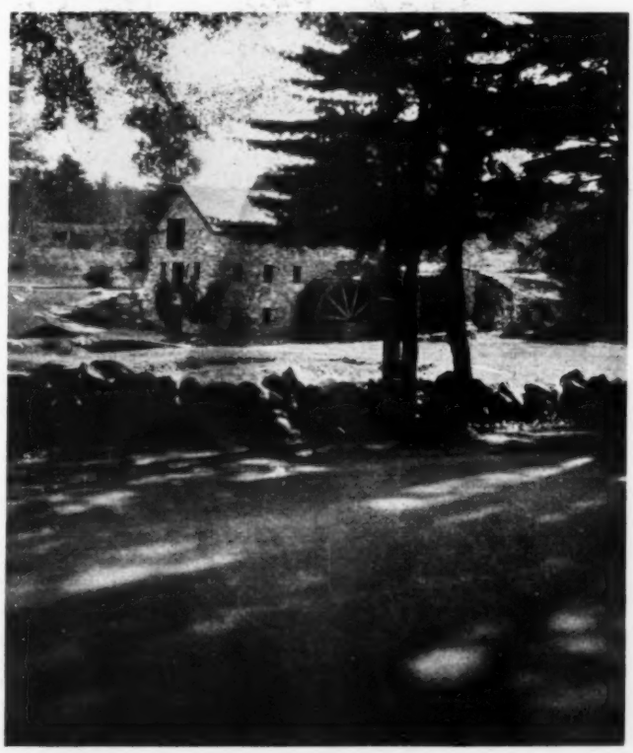
The department has the only battery of Powers tabulating machines in Arizona. These machines have demonstrated their usefulness as accounting aids where the volume of business is large enough to justify them. The department has not made an attempt to reduce the accounting force as a result of the use of these machines. The main advantage secured from them is that the increased volume of work and the varied classes of additional information required in connection with the enlarged activities have been taken care of without additional force.

It was decided prior to the adoption of the present budget that the accounting division could get better cooperation from the field forces if a contact man were added to the force. This was accomplished with no additional expense. One desk in the office which was handling a class of work easily adapted to the machines was abolished. Without additional tabulator-room employees this was done, and the salary applied to the position of traveling auditor. The first six months of the fiscal year have proved the value of this position. Maintenance and construction forces are naturally not office men. To establish correct records in the Phoenix office certain information necessarily has to come from the field forces. The traveling auditor is a valuable help to the field men. He can and does assist them with their reports and straightens out disputed items in much less time than they could be adjusted by correspondence, and with a minimum of friction. It would be a careless foreman who would attempt to carry any straw men on his payrolls under the present system of records used by the department. Properly authorized appointment reports must be sent to the Phoenix office in advance of the payrolls, and no one is paid otherwise. The district engineers and their assistants keep a constant check upon the progress of the work and the personnel of the forces. The traveling auditor supplements this supervision, his duties requiring him to visit the various districts as the occasion demands, and he is thus enabled to keep good records of the activities of the field men.

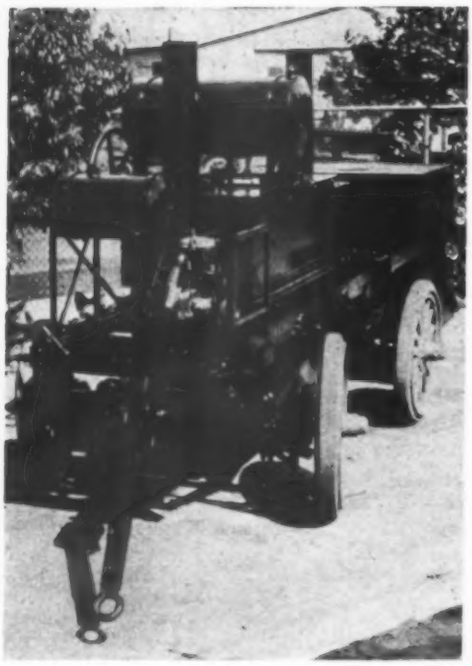
In the past two years the oiling of the highways has been progressing rapidly. The cost of construction of the various types of oiled surfaced roads has been established. The problem now confronting us is to secure a proper segregation of the cost of maintenance of these different kinds of oiled roads. This is one of the most difficult cost problems which has arisen, and we admit we have not settled it to our own satisfaction. We have made a start on it and with the whole team working together (engineers, foremen and accounting forces) we are sure we can and will solve it.

▼

On the Boston-Worcester Road



Old Mill at Wayside Inn. The Road Surface Is Asphalt Penetration Macadam



Asphalt kettle with full drum, heating compartment and power spray distributor, built at the Sacramento headquarters shop

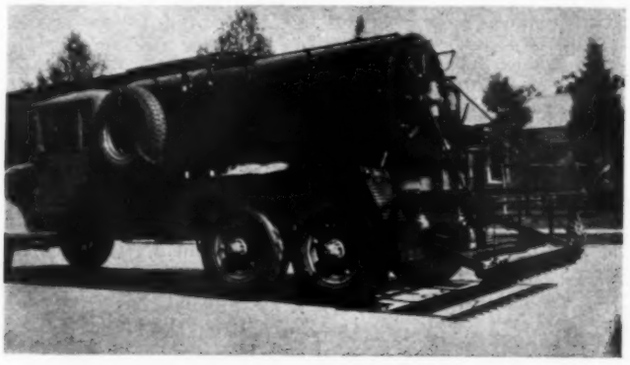
Department Shops Develop Practical Equipment for California Highways

HIGHWAY construction and maintenance equipment developed by the equipment and maintenance departments of the California Division of Highways is shown in the accompanying illustrations. With the exception of the drag broom, which was built by the maintenance department, all of this equipment was developed at the headquarters of the equipment division in Sacramento and at the district shops.

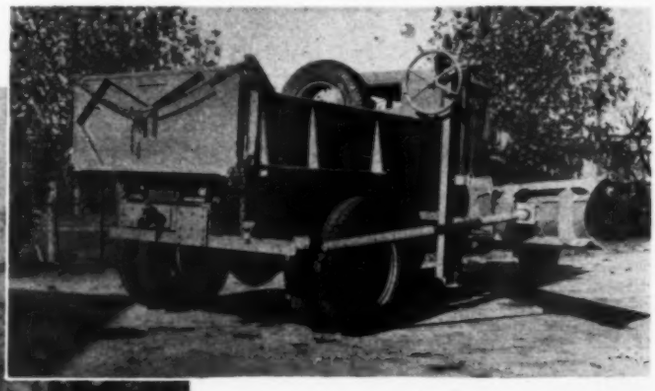
The oil-spreader trailers were designed to save the time lost in transferring oil from a tender truck to a distributor. They have been used only for spreading fuel-oil dust palliatives and for this work they have proved satisfactory, as much as 18,000 gal. of the light oil having been spread in this manner during an 8-hour shift. A feature of the six-wheel distributor truck is a removable rotary oil pump, allowing repairs to be made without the necessity of men entering the tank. Another of the units which has proved highly satisfactory is the portable emulsified-asphalt kettle. Twelve of these have been constructed.

R. H. Stalnaker is equipment engineer, in general charge of equipment, and T. H. Dennis is maintenance engineer.

Portable steam retort used for heating road oil, assembled by equipment department

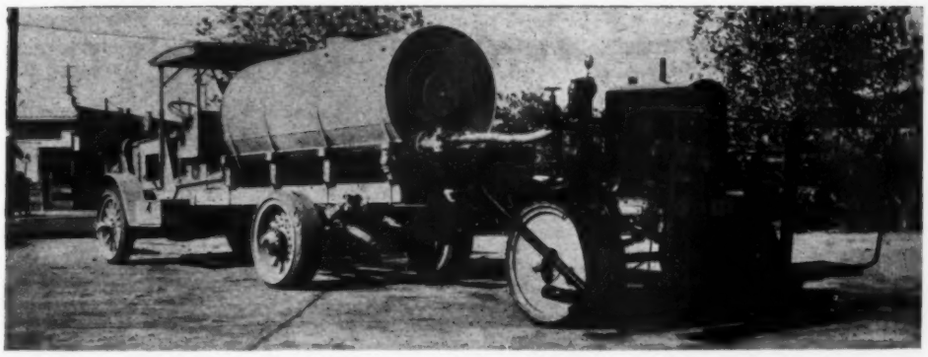


Six-wheel oil distributor with 1,200-gal. tank, assembled by equipment department. The oil pump and the attached piping are removable. Control levers are located to permit operator to face backward while spreading, giving a better view of the distribution of oil

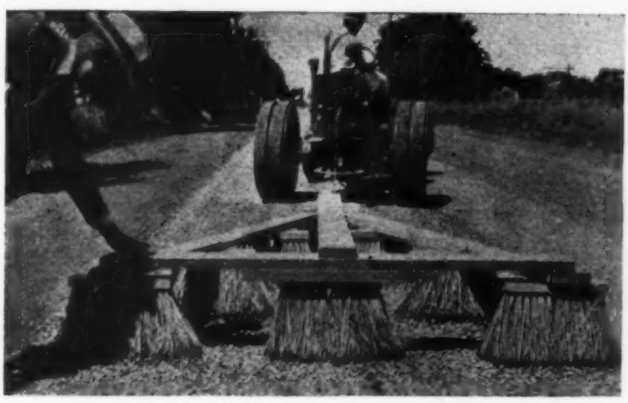


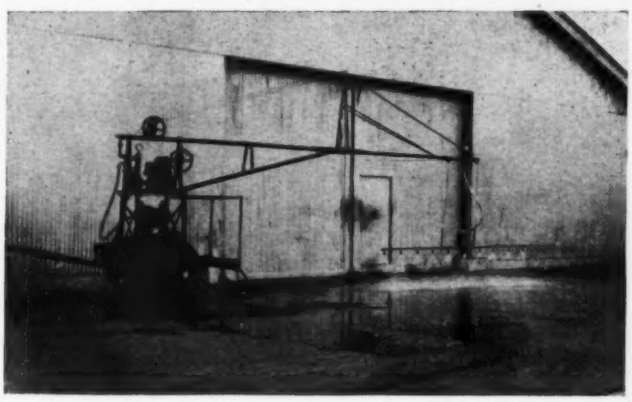
Above—Adjustable blade for widening snow piles or ridges removed from highways

Left—Outrigger snow plow in action at Susanville



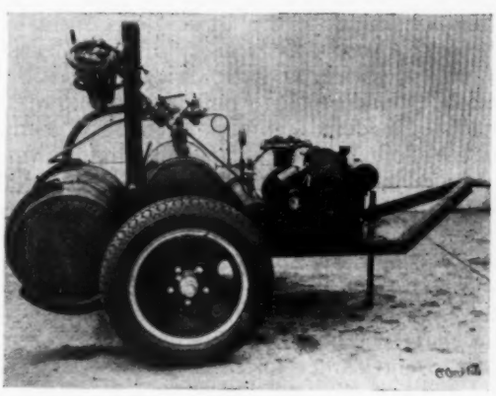
Trailer oil distributor coupled to tank truck. The spreader carries an engine, a power pump and an adjustable spreader boot. It can be coupled to a tender truck in 5 minutes



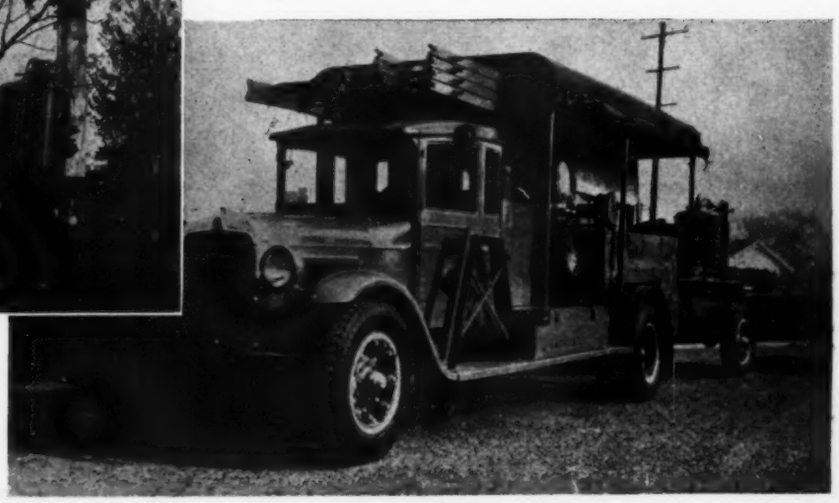


Left—Type of drag broom used in constructing non-skid surface. This broom was built by the maintenance department. Right—Portable weed spray. A two-wheel trailer carries a platform which supports a small engine and a rotary pump and also serves as a turntable for an adjustable arm supporting a 12-ft. length of spray pipe

PICTURES of state highway construction and special equipment are regular monthly features in ROADS AND STREETS. These pages constitute a pictorial history of modern American road-building as practiced from coast to coast



Emulsified asphalt kettle with compressed-air power spray on two-wheel rig for trailing. These units have a low center of gravity, and are comparatively light and easily towed by a light truck



Portable bridge-maintenance unit assembled on a 3-ton truck and a heavy-duty trailer. The outfit comprises an air compressor, sand-blast equipment, a paint-spray machine, tackle and staging, as well as blacksmith and carpenter tools

Low-Cost Roads in New and Undeveloped Countries

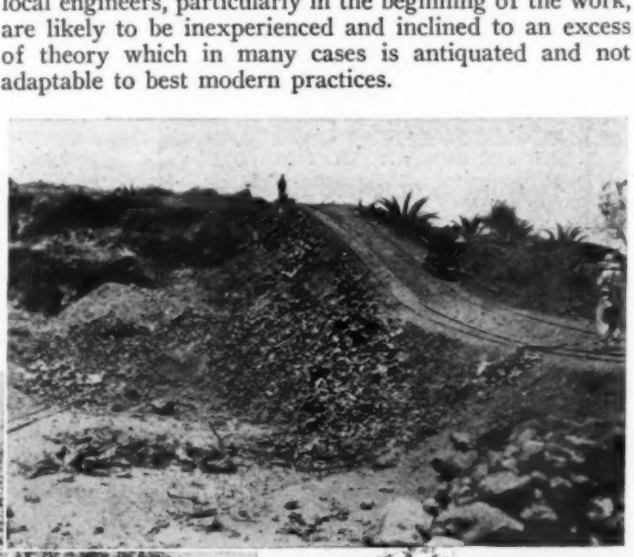
Mexico-Acapulco Highway-Surface of Local Stone and Gravel

By C. N. CONNER
and A. K. HAXSTUN
Chief Engineer and Division Engineer, Mexican National Highways, 1925-26

MOST undeveloped countries have few motor vehicles and practically no highways. Automobiles and trucks are consequently confined to the paved streets of cities and their adjacent suburbs. Such was the condition in Mexico less than six years ago, and such, according to the U. S. Department of Commerce, is the condition now in many parts of Central and South America, Russia and the Orient. In 1925 Mexico successfully undertook to pull herself out of the mud and to build modern highways by what is commonly known in the United States as stage or progressive construction.

Finance.—Because of the small possibilities for taxation in local political divisions of an undeveloped country, it is usually necessary for the central government to supply highway funds, since it has access to larger sources of tax money. It is preferable to take funds for these developments from current revenues because rates on loans may be prohibitive especially in the early stages of a country's development. A most important factor in every case is a sound fiscal policy which covers an extended period of time, at least 5 years, and which will provide funds to cover adequate maintenance as well as construction during this period.

Specifications for the work should be the simplest possible, and all points open to controversy avoided since local engineers, particularly in the beginning of the work, are likely to be inexperienced and inclined to an excess of theory which in many cases is antiquated and not adaptable to best modern practices.



Local Basalt Quarry on Mexico-Puebla Highway

Before the Roads and Bridges Were Built

Native Labor Is Cheap, Willing and Effective in Mexico

A Dry-Rubble Retaining Wall

Location.—Location should be in charge of the best talent available, as this item has a most decided influence on both the original and final cost. Every effort should be made to determine in advance the profits which the road will return to taxpayers. Alignment for trunk lines should be the best obtainable and the routes the most direct. Branch lines to isolated communities are preferable to major deviations from the natural location.

Locations in mountain regions of high-intensity rainfall should be made on low maximum grades, not over 6 per cent, on account of erosion in ditches and the necessity of increasing roadway crown to insure quick runoff from road to ditch. The materially lessened power of gasoline engines in high altitudes, about 25 per cent less at El. 8,000, and the lowered boiling point of the cooling medium are other reasons for not exceeding 6 per cent grades.

Grading.—Grading can be divided roughly into three classifications: plains, piedmont or hilly country and mountains.

In plains and hilly country the powerful tractor and heavy blade grader and elevating grader are the most economical and successful equipment yet devised for grading in all but very rocky soils and deep swamps.

Tractor units for large production and maximum economy can well be operated in units of three, with a small tractor for the odd jobs and two light trucks to carry gasoline, oil and other material.

Grading in mountains cannot ordinarily be done with the equipment used in plains and piedmont sections. Power shovels are usually most economical for side casting in mountain work; but it is essential that the structures and work which cannot be efficiently done with the shovel be carried on sufficiently in advance to avoid delaying the heavy grading equipmet.

Narrow-gauge track and meter-capacity dump cars are excellent for building fills and taking out through cuts by hand. Tip-up dump carts with mules are efficient where the climate is not unfavorable to mules and feed not difficult to obtain. Air compressors and drills for rock excavation show economy of time and money as against hand drilling except in most unfavorable conditions.

Operators for the various pieces of equipment can best be trained from local labor which often shows considerable aptitude. Explosives, always dangerous, must be handled with extra caution where the labor is not accustomed to them.

The assignment of tasks to hand labor is frequently more fruitful of results than fixed hours of toil, often

Two Views on Mexican Highways: Left—Constructing Surface of Volcanic Gravel on Mexico-Puebla Highway. Right—Construction of the Monterrey-Laredo Road—Development of a New Line with Light Grades at Mamulique. Old Road at Left

Mountain Section of the Mexico-Puebla Road, at About El. 10,000. Note Downspouts and Pipe Culverts

showing double or better production for the same cost.

Considerable care is justified in protecting new work from the erosive effect of torrential rains. On earth fills this is best accomplished by small dikes on the sides with frequent discharge troughs of wood, metal or stone. Intercepting ditches on cuts prevent erosion of the slopes.

Structures.—The expense of structures in regions of heavy rainfall is a large item. Because of lack of cheap transportation, the costs of the common structural materials, cement, steel and treated timber, may be very high, often from two to four times the prices in the United States, and it may become necessary to provide substitutes. Limestone, in many cases, can be obtained and burned into lime near the job and lime-bonded masonry will be successful and economical. With stone that can be easily shaped, masonry without bonding material or dry masonry can be used with economy. Durable local woods for culvert tops are satisfactory and often they give long service.

Howe trusses of wood for spans of moderate length may offer an economical solution and all material except the nails and steel rods and washers for tension members can be obtained locally. For longer spans, suspension bridges, with twisted wire multiple cables and with or without wooden Howe stiffening trusses are probably cheapest and satisfactory.

Nestable corrugated galvanized-iron pipe is the best solution of the drain-pipe problem where cement is difficult to transport. If transportation is not too difficult and expensive, job-made concrete pipe may be a good proposition. With a reasonable number of steel pipe forms, the making of concrete pipe in any quantity is a surprisingly cheap and easy job.

The tendency, in most cases, is to make waterways too small and too infrequent. It is invariably more satisfactory to use an oversize than an undersized opening. The amount of traffic and the size and weights of individual traffic units will usually exceed those anticipated and it is well to avoid making structures too light and too narrow.

Surfacing.—This item in the low-cost field covers a variety of types, all of which are more or less satisfactory. The main point is to use local material and keep transportation costs to the very minimum. Field investigations will usually discover material which, either by itself or combined with other local material and manipulated properly, will produce a serviceable roadway.

This material may be sand-clay, topsoil, gravel, chert, decomposed granite, volcanic ash or volcanic waste and water-bound or traffic-bound macadam. Volcanic slag or cinders are difficult to bond and will usually need a light application of clay or other binder.

Surface treatments of bituminous materials are always justified on any of these surfaces. These treatments lessen erosion in the rainy season with attendant loss of material, prevent the loss of material from wind in the dry season, reduce pot-holing and disintegration, and finally lessen maintenance costs and improve the riding qualities of the road itself.

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Work of Indiana Testing Laboratory

The laboratory of the Indiana State Highway Department last year, according to the commission's annual report, received and tested 16,020 samples of materials used in the construction of roads and bridges and in unpaved road maintenance. These materials consisted of sand, gravel, crushed stone, cement, brick, asphalt, tar, rock asphalt, road oil, paint and calcium chloride. In addition the laboratory tested concrete cores removed from new pavement—a precaution in each case before final payments are made—and samples of metal, concrete and vitrified clay pipe used in drainage on state roads.

The more than 16,000 samples received necessitated 166,000 separate tests, all being made with a view to determining proper size, strength, chemical content, absorption, action under heat and cold, workmanship and quality of manufacture. The average daily number of samples received was 53, with 233 samples arriving on the record day. Records show that the laboratory averaged 550 tests daily for the year, with 1,585 tests as the maximum day's work.

More than 75 trained technicians were used by the department at the height of the construction season.

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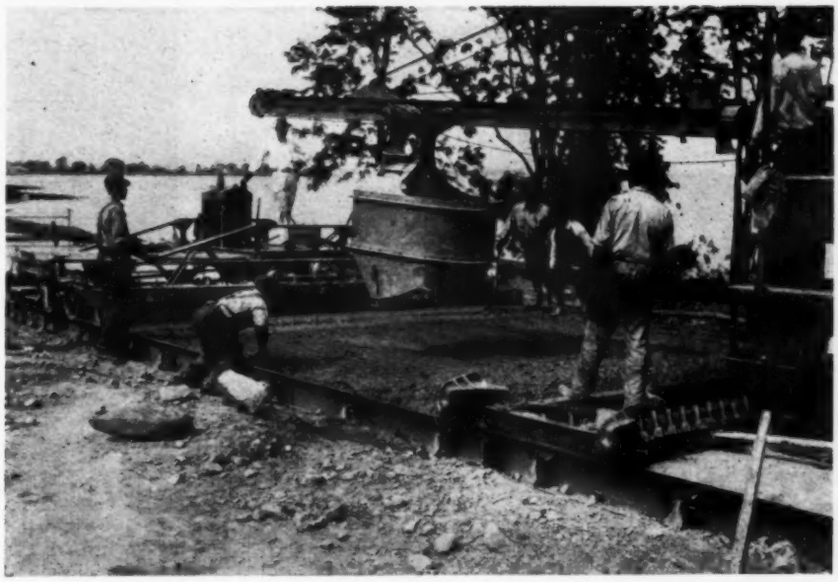
CITY MANAGERS IN IRELAND.—The city of Dublin, Ireland, has adopted the city-manager plan of municipal government.



Wire-Fabric Reinforcing Being Installed on the Mt. Vernon Memorial Highway. The Paved Width of 40 Ft. Is Being Placed in Sections 20 Ft. Wide. Fabric Reinforcing Is Being Placed by the Strike-Off Method, the Strike-Off Being Made by a Hinged Plate on the Finishing-Machine Screed

Methods of Installing Fabric Reinforcement *in Concrete Pavements and Bases*

By JAMES S. BURCH

Research Engineer, Wire Reinforcement Institute, Washington D. C.

THE question of proper and rapid installation of fabricated reinforcement in concrete pavements and bases is always a matter of primary importance to both the engineer and the contractor in charge of projects which include the use of this material. Where maximum daily output becomes necessary, this question often assumes the proportions of a serious problem to those whose experience with the use of reinforcement in pavements is limited. The fact that such reinforcing has been used extensively year after year in numerous fast-moving projects, however, is sufficient assurance that such work may be expediently and accurately accomplished, and that the problem lies mainly in setting up proper job organization, and in synchronizing the various phases of paving operation.

Basic Requirements.—In determining the most satisfactory method of installing fabric reinforcement in concrete pavements, two fundamental requirements must be met: (1) the reinforcing must be accurately placed in the slab; and (2) the installation must be accomplished with economy and facility under job conditions.

The placing of fabric reinforcement in the pavement may be accomplished by either one of two basic methods, which are, briefly:

a. To support the reinforcing fabric at its proper elevation above the subgrade by means of accessory devices of some kind, so that the full thickness of concrete may be deposited directly through the open meshes of the fabric.

b. To deposit the concrete in two separate layers, the first layer being roughly struck off at the proper elevation to serve as a supporting bed for the reinforcing fabric (known as the "strike-off" method).

Thus in planning the details of paving a given project we are confronted with the problem of selecting one of the two basic methods given above. In weighing the advisability of these, it becomes desirable to consider the essential requirements of any installation method from the standpoint of quality, speed and economy. These requirements may be briefly summarized as follows:

1. Such devices as may be used for the installation must not seriously interfere with existing structures, such as manhole castings, valve boxes, etc., and should not, in the case of unexpected paver delay, tend to impair the quality of the completed pavement.

2. The method must not cause interference with final trimming or preparation of subgrade, nor the placing of center or transverse joints, dowels, tie bars, or other incidentals usually required in the slab design.

3. The method must guarantee that the reinforcing members are properly and securely placed in their designed position in the slab; and should not permit undue bending of the steel members.

4. The method must not promote segregation of concrete aggregates and honeycombing, nor induce planes of lamination in the concrete.

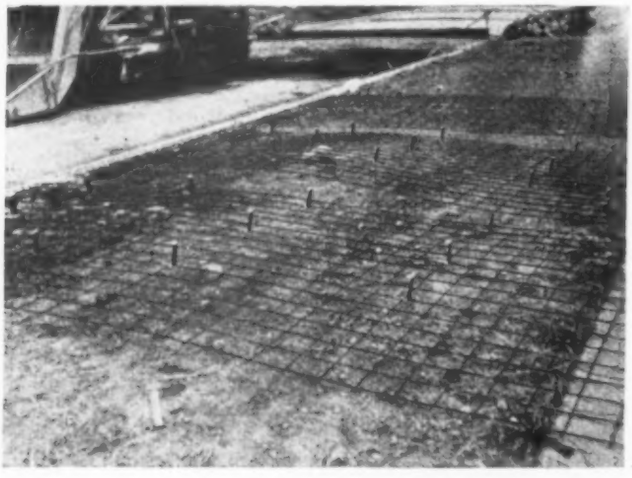
5. The method must not, under any circumstances, delay the rate of paving even at maximum mixer output.

6. The method must require a minimum of labor used either directly for installation or indirectly connected with the placing of the reinforcing, and should require minimum expenditures for special equipment.

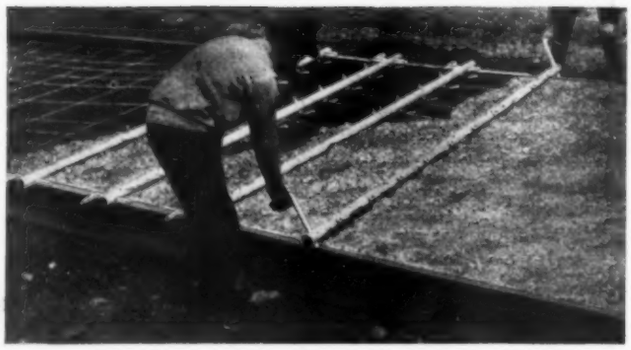
Installation Devices.—During the past ten years, we have witnessed the development of many devices designed to support the fabric in one way or another, so that the concrete might be deposited through the open

meshes and thus eliminate the necessity of placing the concrete in two layers. The development of these devices was predicated upon the supposition that an intermediate strike-off would tend to delay paving and would require excess labor. Experience, however, has shown that the importance of being able to pour full depth was overemphasized. The use of each of these devices has shown certain undesirable features, with the result that many of them are no longer extensively used. One of the first of these devices used was a chair which rested on, or was driven into, the subgrade at intervals under the fabric, to hold it in position. In addition to the fact that considerable time was required for the placing of these supports, the chair method provided insufficient support for the fabric, with the result that the reinforcing was not properly located in the slab. Overhead swing supports resting on the forms and holding up the fabric from above by means of hooks or fingers have shown the same weakness of support and in addition have proved cumbersome, have become heavily encrusted with concrete and have tended to delay paving speed on fast-moving jobs by reason of the necessity of constantly moving these devices ahead as paving progresses.

A device usually termed a sled was developed and has been used extensively in numerous forms. The sled is composed of a series of parallel steel members from 1 to 4 ft. apart serving as runners, connected at one end by a steel cross-member. The sled is placed on the subgrade with these parallel members or runners in the direction of paving operation. These runners have a vertical dimension of from 4 to 8 in., depending on the slab thickness, and on them is placed the reinforcing sheet, through which concrete may be deposited to full slab depth. This frame or sled is connected to the mixer so that when the latter moves to a new position the sled is withdrawn, leaving the reinforcing sheet in its proper position 2 in. below the final concrete surface. At first these supporting sled members were made of 1½ to 3-in. pipe, but the use of such sleds caused actual voids in concrete slabs in many cases. In an effort to overcome this condition, sleds were made using inverted T-sections with thin vertical webs, and many sleds of this design are now being used. In many cases it has been found that the use of these T-members caused laminations in the concrete, and recent efforts have been directed toward eliminating this lamination.



Pin and Chair Supports Have Proved Flimsy and Inaccurate Devices for the Support of Fabric Reinforcing. The Weight of a Man, or Even of the Concrete Itself, Is Sufficient to Warp the Reinforcing Badly Out of Position



Overhead-Type Installing Device, with Which Fabric Reinforcing Is Supported by Hooks or Fingers Attached to Cross-Bars. This Type Is Being Used to a Limited Extent at Present

An improved type of sled has been developed wherein longitudinal runners are used having open webs with thin top and bottom rails, the web members being provided with thin cutting edges so as to induce a minimum width of lamination in the concrete on removal. Also, this device includes the use of a loose ring or chain link at the end of each member for the purpose of breaking up any laminated plane which may have formed as the device is withdrawn from the concrete.

Objections which have been set forth to the use of the so-called sled method may be briefly outlined as follows:

1. The slender web members, on being pulled forward out of the concrete, create planes of lamination within the concrete, which has become slightly consolidated prior to the withdrawal of the sled. In this way there is a possibility that the larger aggregates will not assume interlocking positions across the laminated plane, even under the action of the finishing machine; the plane may be only partially filled with mortar or with laitance water, with the possibility of a crack resulting at this plane later in the life of the pavement slab.

2. Since the sled advances with the mixer there is no opportunity to correct properly minor subgrade irregularities after the mixer has moved over the section of subgrade in question.

3. Final sprinkling of the subgrade must be made through the sled; thus the soil immediately under the members may be of much lower moisture content than the remainder of the subgrade, possibly inducing unequal soil expansion, or absorption of water of hydration in the concrete, with resulting cracks of the shrinkage variety.

4. Since the fabric sheet must be placed on the sled prior to pouring the first batch after a mixer move, both the sheet and the sled members interfere with the prompt installation of the center joint, tie bars, expansion-joint bulkheads, dowel bars and other incidental items which usually must be placed.

5. Especially in urban construction, the use of the sled is constantly interfered with by the existence of manhole castings, valve boxes and other structures.

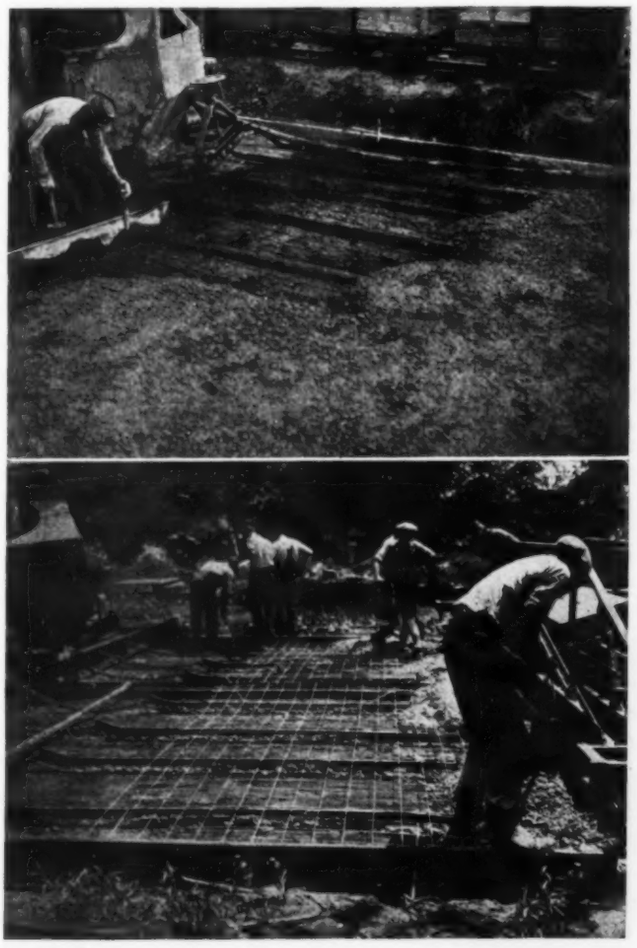
6. With the fabric supported by sled devices, it is almost necessary that the laborers spreading concrete and installing joints walk on the supported reinforcement, thus tending to bend it out of proper position in the completed slab.

7. In the case of paving delays, the sled members

may inadvertently be allowed to remain in the concrete until it has approached its period of initial set, in which case the removal of the sled may leave decided planes of weakness in the slab, and also the concrete may adhere to the web members to an undesirable extent.

It is claimed that the improved type of sled or slide installer gives very satisfactory results, and that actual cores taken from finished pavement fail to reveal any indications of lamination in the concrete. This particular device, however, has not come into general use, and it cannot be definitely stated that it will entirely prevent aggregate separation. This tendency to leave laminations or voids in the concrete is a basic objection which may be applied to the use of any installing device of the sled type, although some types are undoubtedly far more efficient in preventing the occurrence of this objectionable feature than are others.

Even though this objection of lamination may be discounted with the improved slide installer, there remain certain other basic objections to the method worthy of consideration as enumerated above. As regards facility of installation, it may be pointed out that any method which includes the use of supporting devices requires that these devices, as well as the reinforcing, be placed at a time when there are numerous other duties to be performed in the subgrade pit, and it is probable, as we shall later see, that the use of any of these methods will tend to promote delay in paving.



Two Types of Sled Device, the One in the Upper Picture Being Made of Pipe Runners and the One Below Using T-Sections. These Types Preceded the Development of the Improved Sled Device, Which Uses Open Web Members. The Type Shown Above Is Practically Obsolete; the Device Shown Below Is Being Used to Some Extent at Present

Improved Type of Sled Device with Open Webs and Thin Top and Bottom Rails. It is Claimed that the Use of This Device Does Not Promote Lamination Planes in the Concrete Slab on Removal

The Strike-Off Method.—Long experience of a number of engineers and contractors who have built reinforced concrete pavements in a number of states has indicated clearly that the strike-off method is in general to be preferred. By this method, the concrete is deposited on the subgrade and is roughly leveled by means of a strike-off board or template to an elevation 2 in. below the final concrete surface. The reinforcing sheet is placed on this bed of dense, pre-struck concrete and then additional concrete is deposited on the steel to form the cover, which is screened and surfaced by the usual finishing methods.

It is generally accepted that the strike-off method presents the most effective means of placing the reinforcing sheet firmly and accurately in its proper position in the concrete slab. Since it is placed on an evenly-surfaced bed of concrete, the necessary walking of the laborers does not tend to bend or distort the reinforcing sheet to any extent. Also since the surface batches are placed immediately, there is no possibility of a lamination plane occurring.

Since the concrete is to be placed by this method in two struck layers, it often appears, at first thought, that the labor and time required would be prohibitive. This argument has often been advanced by those who have had little or no experience in placing sheet reinforcement, and appears to be founded more upon supposition than upon actual fact. A careful analysis of this method shows that there is no reason for any delay in paving operations whatever and, further, that but very little additional labor or equipment is required as compared to any other method.

Detailed Job Procedure.—A detailed consideration of the various paving operations and phases will indicate clearly the reasons why the strike-off method creates no delay or excess labor. By reference to the installation sketch, Fig. 1, based on a typical paving-job set-up, will serve to explain the details of this method. The exact number and arrangement of laborers on a given paving job does not necessarily have to conform to the organization as shown in this sketch. It is not necessary, for instance, to use four men to lift and place a reinforcing sheet. This sketch is presented primarily to show the

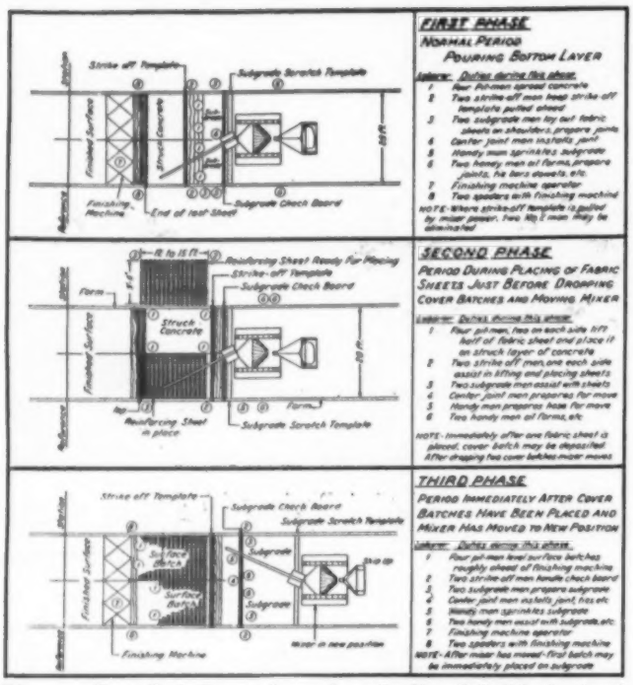

FIRST PHASE
NORMAL PERIOD
POURING BOTTOM LAYER
SECOND PHASE
PERIOD DURING PLACING OF FABRIC SHEETS JUST BEFORE DROPPING COVER BATCHES AND MOVING MIXER
THIRD PHASE
PERIOD IMMEDIATELY AFTER COVER BATCHES HAVE BEEN PLACED AND MIXER HAS MOVED TO NEW POSITION

Fig. 1—Detailed Procedure for Strike-Off Method of Installing Fabric Reinforcement in Concrete Pavements

sequence of pouring and installation operations, rather than to serve as a rigid guide for labor organization.

In the first phase, the period during normal pouring of the lower layer, the reinforcing has not yet been placed and concreting is proceeding at the normal rate. Batches are being dumped on the subgrade to a depth 2 in. less than the pavement thickness, the pit men (No. 1 in Fig. 1) are spreading the concrete and the strike-off men (No. 2 in Fig. 1) are pulling the strike-off board ahead, roughly leveling the concrete 2 in. below final surface. It is found very desirable to keep the strike-off board pulled closely behind the pit men, so that they may have close at hand a thickness guide to which to work in spreading the concrete. In this way the work of the strike-off men is kept to a minimum. Thus by the time the last batch for the lower layer has been dropped, it may be at once spread and struck-off.

At this point the reinforcing sheets may be placed. Immediately (second phase, Fig. 1) two pit men (No. 1) and possibly one or two other men (No. 2 and No. 3) lift a reinforcing sheet from one shoulder and place it in its proper position on one side of the roadway. This requires but a few seconds and immediately the mixer operator may deposit the cover batch on this side. In the meanwhile, a reinforcing sheet has been placed on the opposite side of the center-line, and the cover batch for this side may be dropped here when it has been mixed the required length of time. When the second cover batch (two-lane width) has been dropped by the mixer operator, the mixer moves at once to its new position.

As the mixer begins moving forward (third phase, Fig. 1), the subgrade men (No. 3), center-joint man (No. 4) and handy men (No. 5 and No. 6) begin at once to prepare and check the subgrade pit, and install necessary joints, etc. When the mixer has moved the proper distance and has discharged the first batch from the drum to the bucket, enough subgrade has been checked to receive the first two subgrade batches, one in each corner. Attention may be called to the fact that this phase is the one in which mixer delay is most likely to be caused on the usual job, and that with this method the entire subgrade pit is clear, and no reinforcing is to be placed at this time which might tend to delay maximum speed of operation. By the time about two batches have been dropped in the new pit, the concrete shovelers (No. 1) have completed the spreading of the surface batches in the previous section to the extent that the finishing machine may complete this section. These men then begin work spreading concrete in the new pit, and the operation again enters the normal period of pouring bottom layer (first phase, Fig. 1)

The Critical Period for Delay.—There are two periods during paving operations during which fabric reinforcing may be placed. The first is the period immediately after the mixer has moved to a new position. If supporting devices of any kind are used the reinforcing must be placed during this period. The second is the period immediately before a mixer move, and it is during this period that reinforcing may be placed by the strike-off method.

In considering the proper method, it becomes expedient to consider the available time for the installation of reinforcing within the period when it must be placed under each method. Figures 2 and 3 are typical time-interval charts compiled to show graphically the usual time consumed by the various operations within the periods during which reinforcing must be placed by each of these methods. The figures on which these time intervals are based are taken from paving efficiency studies made by J. L. Harrison, of the U. S. Bureau of Public Roads as published in *Public Roads*, Vol. 6, No. 9. These figures assume a 1-minute mixing time, a two-lane-width slab with modern equipment and organization, and maximum speed of paving—one batch discharged from the drum every 75 seconds.

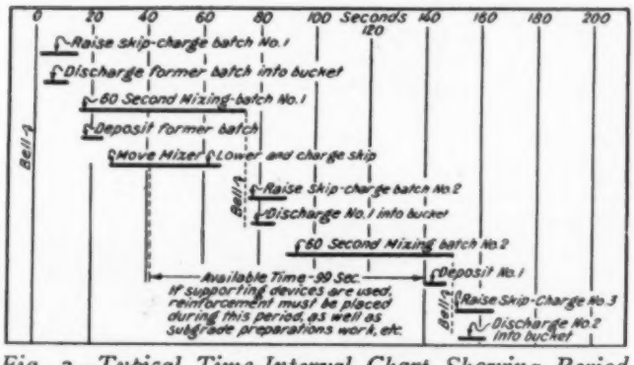

0 20 40 60 80 100 Seconds 120 140 160 180 200
Raise skip-charge batch No. 1
Discharge former batch into bucket
60 Second Mixing-batch No. 1
Deposit former batch
Move Mixer
Lower and charge skip
Bell 4
Raise skip-charge batch No. 2
Discharge No. 1 into bucket
60 Second Mixing batch No. 2
Available Time-99 Sec.
If supporting devices are used, reinforcement must be placed during this period, as well as subgrade preparations work, etc.
Deposit No. 1
Raise Skip-Charge No. 3
Discharge No. 2 into bucket

Fig. 2—Typical Time-Interval Chart Showing Period During Mixer Move-Up Operations; Based on Maximum Speed for 1-Minute Mix

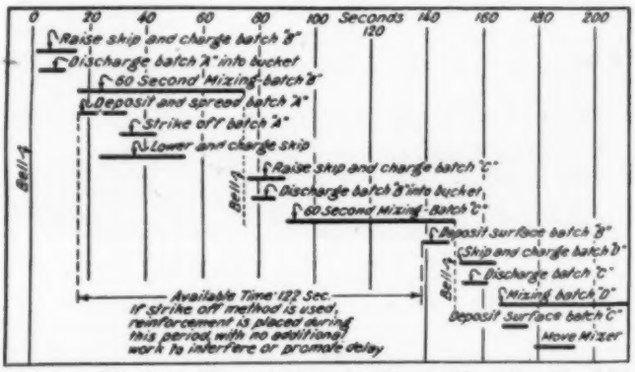

0 20 40 60 80 100 Seconds 120 140 160 180 200
Raise skip and charge batch "B"
Discharge batch "A" into bucket
60 Second Mixing batch "B"
Deposit and spread batch "A"
Strike off batch "A"
Lower and charge skip
Bell 4
Raise skip and charge batch "C"
Discharge batch "B" into bucket
60 Second Mixing Batch "C"
Deposit surface batch "B"
Skip and charge batch "D"
Discharge batch "C"
Mixing batch "D"
Deposit surface batch "C"
Move Mixer
Available Time 122 Sec.
If strike off method is used, reinforcement is placed during this period with no additional work to interfere or promote delay

Fig. 3—Typical Time-Interval Chart Showing Period Immediately Before Mixer Move; Based on Maximum Speed for 1-Minute Mix

Installing Fabric Reinforcing by the Strike-Off Method. Concrete Bed Has Been Struck-Off and Is Ready for the Placing of Reinforcing Sheets

Figure 2, a time-interval chart for the period immediately succeeding a mixer move, shows that the necessary sequence of operations involved in the mixing and pouring of the concrete is such as to make available an interval of not more than about 99 seconds for performing all auxiliary operations preparatory to depositing the first batch of concrete. This condition exists whether or not reinforcing is used, and it is evident that if reinforcing is placed by any method which employs supporting devices, it must be placed during this 99-second period, in conjunction with such additional operations as final preparation and wetting of subgrade, checking of subgrade, placing center and transverse joints with dowels and tie bars and placing of other incidental items customary in paving designs.

In Fig. 3, which is a time-interval chart for the period immediately preceding a mixer move, it is shown that there is an interval of about 122 seconds available before delay can be caused. If reinforcing is installed by the strike-off method, it is placed within this period. Thus there is available a period 122 seconds during which it is necessary only to deposit and strike-off the last batch of concrete in the lower layer, and place one sheet of reinforcing on the struck bed of concrete. Actually it is found that this work may be conveniently done within less than 54 seconds, so that there is a safety period of 68 seconds before delay can be caused.

Thus we see that in any paving project, whether reinforced or not, the period during which delay is most likely to be caused is the time just after the mixer has moved to a new position. By the strike-off method, no work connected with the use of reinforcing must be done during this period, and therefore the placing of reinforcing by this method does not introduce any tendency to delay whatever during this period. Rather, the reinforcing is placed during a normal mixing period when no additional operations are necessary which would interfere and promote delay.

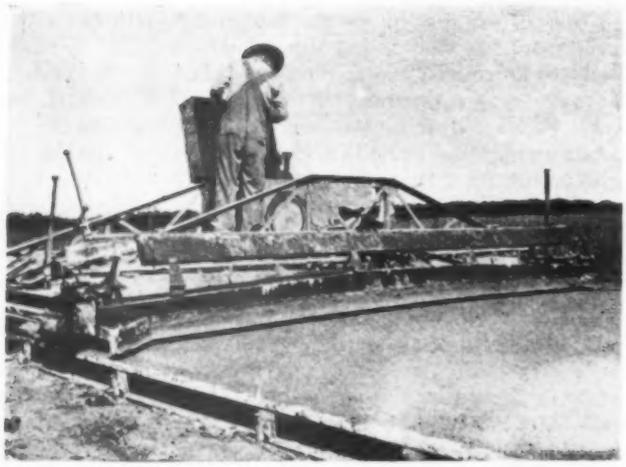
The strike-off method is the only means of installing fabric wherein the subgrade pit is allowed to be left open clear for the proper subgrade and preparation work in the pit, and for the immediate pouring of the first batches after the move.

Thus the strike-off method, when properly adapted to the paving operations, is the least likely to promote delay of all methods, and therefore is the most desirable from the standpoint of maximum speed of paving.

Labor Requirements.—At first thought, it would appear that the strike-off method would require extra labor as compared with other methods, notably the use of the sled. This is probably true, but the additional labor required is very small. If the mixer operator will spread the batches on the subgrade to approximate the proper thickness, and the usual number of concrete shovel men will roughly level off the surface, two men will have no difficulty in making the strike-off with a properly designed template or board. These two strike-off men are the only additional laborers required by this method, and they do not have to be trained or skilled. In addition to making the strike-off, these men may be used to pull the subgrade check-board and assist with the placing of reinforcing spade edges and do other incidental work.

The Power-Operated Strike-Off.—A somewhat recent development of the strike-off method, as used extensively on Pennsylvania state highway construction, is to attach the strike-off template by cables to a power-take-off shaft on the mixer. In this way the mixer operator may pull the strike-off board ahead at will, and thereby these two laborers mentioned above may be dispensed with entirely. This method with the use of the power cable is generally favored by paving contractors in Pennsylvania and is being used to some extent elsewhere. The installation of the take-off shaft

The Strike-Off Method. Concrete Has Been Fully Struck-Off, Fabric Reinforcing Sheets Have Been Placed on Each Side and a Cover Batch Has Been Spread on the Side of the Road Nearest the Camera. When One More Cover Batch Has Been Deposited, the Mixer Moves to a New Position and the Finishing Machine Proceeds with the Screeding Work



Hinged Plate on the Screed Board of a Finishing Machine as Used in Some Localities to Make the Strike-Off of the Lower Layer of Concrete Prior to Placing Reinforcing Sheets

on the mixer may be easily arranged with the mixer manufacturer, and it is understood that the cost of this device installed is not more than $200 to $250. Once installed, it may be used continuously throughout a number of paving projects.

Experience With the Strike-Off Method.—In time efficiency studies made by the Pennsylvania State Highway Department it was found that, using the strike-off method, with or without the power-cable device, during the paving season of 1930, there were a number of contractors who made seasonal paving efficiency averages of from 92 to 97 per cent. In other words, these contractors, using the strike-off method, poured from 92 to 97 per cent as many batches as was physically possible throughout the entire season, limited only by the required mixing time, and with the only delays deductible being due to bad weather and moving equipment to new location. Further, such delays as were occasioned were due altogether to reasons other than mixer delay caused by the placing of reinforcing sheets. From this and other data, it may be definitely concluded that the installation of reinforcing by the strike-off method causes no delay in paving progress.

Use of Finishing Machine for Strike-Off.—Another adaptation of the strike-off method used extensively in New York, New Jersey and elsewhere employs the usual finishing machine to make the strike-off. In this method a hinged plate is attached to the face of the finisher screed board so that when the hinged plate is let down, it will make the strike-off 2 in. below the final paving surface. In this way hand operation of the strike-off, with the corresponding labor, may be eliminated. This adaptation of the strike-off method is used primarily in lane paving, where the pouring is done half at a time in lanes 9, 10 or 11 ft. wide. Reports from these states show that no delay is experienced in using the finishing machine for the strike-off when paving is being done at the rate of from 800 to 1,200 lin. ft. of 10-ft. concrete in a normal working day. It must be remembered, however, that in making the strike-off, the finishing machine must advance over the lower layer and then retreat to the length of a fabric sheet before the reinforcing may be placed. Also, the machine, in addition to its usual finishing work, must maneuver to be in position for the strike-off at the proper time, in order to avoid paver delay. It is possible that, on a fast moving paving job, this method may cause some delay unless the operations are accurately synchronized.

Pouring With Mixer Outside Forms.—In lane paving of widths up to about 12 ft. it is often found expedient to place the mixer outside the lane being paved. One of the primary purposes of such a set-up is to avoid hauling on the prepared subgrade. The same general plan of procedure for installing reinforcement may be followed as in the cases where the mixer travels between the forms on the subgrade. The hinged plate on the finishing machine has been extensively used for making the preliminary strike-off on such projects. In view of the fact that the mixer is free to move backward as well as forward when pouring from outside the forms, it is possible to pour the lower layer in fairly long sections before placing the reinforcing and the cover batches, section lengths of 40 ft. not being unusual.

General Conclusions.—From this discussion it may be seen that the strike-off method meets every essential requirement for satisfactory installation as enumerated heretofore. A detailed study of this subject, fully substantiated by experience, indicates clearly that of all the methods tried, the strike-off method, whether the work be done by a template pulled by hand, or by cables attached to a power-shaft on the mixer, or by running out the finishing machine, is the most desirable method of installing fabric reinforcing from the standpoint of effective installation, high-speed production and economical construction costs.

One of the most important observations made in this study was that the time at which reinforcing is placed determines largely whether or not the installation will tend to promote delay. If reinforcing is placed just after the mixer moves up, as is always necessary when supporting devices of any kind are used, there is so much pit preparation work to be done that there is a tendency for paving speed to be delayed by the installation of the reinforcing. If, however, reinforcing is placed during a normal period, as by the strike-off method, the possibility of resulting delay is very remote and there is no reason whatever for the paving progress to be decreased by the use of reinforcing.

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Road Magnet Collects 3.76 Lb. of Metallic Articles per Mile

During the summer of 1929 the Bureau of Maintenance of the State Highway Department of Missouri constructed a road magnet mounted on a truck for the purpose of ridding gravel road sections of metallic articles. This apparatus consists of a 135-volt compound-wound generator equipped with panel voltmeter, ammeter and automatic discharge switch, powered by a 5-hp. gasoline engine. All of these various units are mounted on a 2-ton truck chassis. Beneath the truck on each side and in the center at the rear are mounted three circular magnets weighing approximately 960 lb. each. This unit is operated over gravel sections at the rate of from 8 to 10 m. p. h., and has proved to be a highly satisfactory and valuable piece of equipment.

This unit was operated 55 days from Oct. 14 to Dec. 15, in 1929. During this period the magnet was operated for a distance of 3,102 miles, and collected 5,715 lb. of metallic articles. During 1930 this unit was operated a distance of 7,212 miles from April 1, to Sept. 30, or over a period of 146 days. During this period of operation 27,053 lb. of metallic articles were collected. The average daily collection in 1930 amounted to 185 lb., or an average per mile operated of 3.756 lb.

Resurfacing Old Roads

Hot Asphalt Macadam Resurfacing Job Under Way

with Hot-Mixed Asphalt Macadam

By C. W. SIMPSON

President, Federal Asphalt Paving Co., Hamilton, Ohio

THE introduction of hot-mixed asphalt non-skid macadam as a surfacing material on Ohio roads came in September, 1930, the result of a contract awarded to the Federal Asphalt Paving Co. in July by the Ohio Division of Highways, for the surfacing of 4 miles of the Oxford-Millville road, U. S. Route 27, between the villages of Millville and Venice in Butler County. This is a section of road on what is known as the Colerain Pike, from Cincinnati through the villages above named, on to Oxford and Indianapolis. This road carries a very heavy traffic and will prove a good test for the material used. The road resurfaced was an old gravel road and the work was simply reclamation, no attempt being made to regrade the road or re-berm it.

The contract called for the laying of hot-mixed asphalt macadam to a depth of 1½ in. In the laying of this surface, while as stated above no attempt was made to regrade the road, some extra material was used to obtain a good crown and a smooth riding surface, so that in the last analysis enough material was used to show an average depth of 2 in.

The Specifications.—In the advertising of bids for the road, the state highway department simply revised an existing specification known as T-5. In the regular T-5 specification, a filler dust is required and also a seal coat. These two items were cut out, leaving the specification with enough variation to allow us to lay what we term hot-mixed asphalt non-skid macadam, as we advocated. However, when the inspectors from the highway department arrived upon the job and took charge of the mixture, they insisted upon using a large proportion of fine sand, insisting upon Lake Erie sand. The mixture was set and re-set, and then set and re-set again. In all, we had about nine men from the highway department, including the heads of the laboratory division, and finally the assistant chief engineer of the maintenance department, who revised the specification prior to advertising for bids. The result of all of this was that the mixture as laid on the first 2 miles, while substantially what we had hoped to lay, was really far from the mixture we had advocated in our promotional work in the department. After laying the first 2 miles, the inspetcors and engineers decided to allow the mixture to proceed in accordance with our ideas, which are within the specifications as the basis of the contract.

The mixture used on the last 2-mile stretch consisted of crushed gravel, or boulders, ¼ to 1½ in. in size, washed river sand and asphalt cement, mixed in proportions as follows:

	Per Cent
Asphalt cement	6.1
Sand	35.3
Stone	58.6
Total	100.0

All fine sand was eliminated. The result is a firm, solid mixture, the large percentage of stone used giving it inherent stability, the coarse washed sand and high bitumen content making a mortar that makes the surface waterproof, yet with a gritty finish that renders the pavement as near non-skid, we believe, as a bituminous pave-

Completed Hot Asphalt Macadam Surface

ment can be. The cost was slightly over $9,000 per mile.

First Laid in 1922.—In 1922, my company was engaged in the laying of a 70,000-yd. contract for the city of Bluefield, W. Va. At that time, due to certain circumstances, including the necessity of keeping the expense of their pavement within a certain sum, the officials of that city felt it would be necessary to lay a portion of that work of some material or mixture of materials that would cost less than sheet asphalt concrete. The matter was put up to the officials of my company to work out something that could be laid more economically than sheet asphalt and asphaltic concrete, yet that would be a serviceable type of construction. Our asphalt chemist, superintendent and general manager combined their ideas with the result that we introduced what we term hot-mixed asphalt macadam, the mixture being crushed stone from ¼ to 1½ in. in size, 30 per cent of Norfolk Beach sand (not a fine asphalt sand, but a mason sand) and about 6.1 per cent bitumen. We laid about 15,000 yd. of this mixture at that time for the city of Bluefield, on Bluefield Ave. between Poplar St. and the Virginia state line, one of the principal thoroughfares through the city. The mixture was laid over an old waterbound macadam pavement, the holes in it being simply filled up with the mixture and brought up to a proper contour for the surface.

The result obtained in the laying of this mixture in Bluefield was so gratifying that my company immediately began the promotion of this mixture in other places where it was advisable to promote something of a more economical nature than the more costly types of bituminous pavements, such as sheet asphalt and asphaltic concrete. Since 1922 we have laid in various places, all without the state of Ohio, about 350,000 sq. yd.

Acknowledgement.—The foregoing is an abstract of a paper presented at the Toledo, Ohio, meeting of the Asphalt Contractors' Association.

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WOOD FORMS AS TRAFFIC GUIDES.—In building asphaltic concrete pavement on the state highway system in California, timber side forms are left in place to act as traffic guides as long as they last.

WHERE THE MAINTENANCE DOLLAR GOES.—The recently issued 7th biennial report of the Division of Highway of the Department of Public Works of the state of California contains the following analysis of expenditures for the years ending June 30, 1927, and for June 30, 1930, showing the distribution of the maintenance dollar.

Where Spent	Year Ending June 30, 1927, Ct.	Year Ending June 30, 1930, Ct.
Traveled way	54.5	52.1
Roadside	30.7	26.7
Improved shoulders	3.0	8.9
Structures	6.4	4.2
Safety devices	2.0	3.8
Drifts (snow and sand)	0.6	1.4
Trees	1.2	1.3
Miscellaneous	1.6	1.2
Engineering	...	0.4
Total	$1.00	$1.00

Under class of work perhaps the most interesting indication as to trend of maintenance work may be noted from the increased expenditures for work on improved shoulders. The 1927 costs show that 3 per cent of maintenance funds were used on the improved shoulders while the 1930 costs show 8.9 per cent. Perhaps no single contribution to safety of traffic can be of more benefit than a wide well-kept shoulder. Another item is the increased expenditures for safety devices which increased from 2 per cent in 1927 to 3.8 per cent in 1930. The expansion of snow removal activities is reflected in the increase of expenditures from 0.6 per cent in 1927 to 1.4 per cent in 1930.

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GRADE-CROSSING STUDY.—During the past two years a cooperative study has been made by the California Division of Highways and the state railroad commission to compile a complete and correct list of all railroad crossings of the state highways. This tabulation shows, for each route of the state highway system, whether the crossing is overhead, a subway or a grade crossing. It also shows which grade crossings have been eliminated in the last two fiscal bienniums, with grade-crossing-elimination program over the next 10 years.

HIGHWAY *Financing as a Productive* INVESTMENT

Improved highways are an income-producing investment rather than a matter of governmental expense

By THOS. M. MACDONALD
Chief, Bureau of Public Roads, U. S. Department of Agriculture, Washigton, D. C.

ABOUT two decades have passed since one of our states, predominantly agricultural in character, built its first mile of rural paved roadway. The cost was financed in part from public funds and in part from private contribution. Not at that time nor for many years following did anyone foresee that the same state would be able, as it was in the one year, 1930, to finance and to build more than 1,000 miles of standard paved roadways, or that by the end of 1932 its system of primary rural highways would be nearing completion to modern standards of construction.

The Road User Paid.—Even with statistical proof it is difficult to convince the public at large, much less those of other countries, that the cost of this whole primary-road improvement program has been predicated upon the road-user taxes; i. e., the earnings of the highways themselves, plus a small percentage of aid from the federal government. Not only is this a true statement of fact, but also for some years the state has taken annually from its income from road-user taxes a large sum to aid the improvement of secondary roads.

While this is a noteworthy illustration of the earning capacity of highways as a single instance, it is recited here as typical of what is taking place in a large number of our states whose experience has followed the same broad outline, varied principally in detail and in rate of progress.

Highways an Income-Producing Investment.—The substance exists in abundance upon which to turn this discussion into an exhortation of faith—faith in improved highways as an income-producing investment rather than a matter of governmental expense. Just now this is a note to be accepted to combat some of the false economy measures which are widely urged as a means to help end the world-wide economic depression.

This, or any other time, is not the proper time for a hysterical expansion of road building far beyond the capacity of the established organizations to adminster or to build efficiently. But there has never been a period in modern times when a reasonable expansion of highway improvement has been supported by so many good and financially sound reasons. World-wide prosperous conditions would offer more good reasons for curtailing road work than the present situation, although it will be many years before any country can afford to curtail a reasonable annual program of new work in addition to a progressively more exacting maintenance of existing roads. Depression is producing roads at costs so low in comparison to former prices that the interest charges can be carried for some time before the total will reach what has been considered a fair price. At the same time employment is provided that materially aids a bad situation.

During February of this year, a month of minimum possibility for using labor on the roads, more than 170,000 men were employed on state and federal-aid road work, which does not include any local road employment. This number is rapidly increasing as weather conditions permit. When the economic pendulum swings the other way prosperity will throw additional traffic to the roads, which must be provided for with new construction.

Separating Expense from Productive Investment.—These comments are induced by the temper of the moment to criticize governmental expenditures *in toto* without any attempt to separate expenses from productive investment. The present adverse conditions will pass, but along with the material causes for a return to more normal conditions, the elements of faith and far-seeing judgment will be potent factors in world-wide economic restoration.

Thus a discussion of highway finance, to be of any immediate value to an organization of international complexion and influence, must concern itself with fundamentals, which may be affected but cannot be proved unsound, by adverse conditions.

As a background there are certain essential considerations. The establishment of sound methods of financing must be predicated upon the time element and provide for continuity of operations. The improvement of modern highways adequate for any nation is a long-time undertaking, and to be accomplished must be established on a continuing basis. The annual rate can be expanded or contracted, but only reasonably so if the work is to be carried on economically and efficiently.

Much has been written concerning the changes brought about by the invention of the internal-combustion engine, but very little academic discussion has centered around the perfection of the pneumatic tire, and its importance to the growth of highway transport has not been as yet fully evaluated. This combination has produced such wide flexibility in sizes and capacities

of loads, such speeds, such riding comfort and in general such wide and unfettered utility in transportation that the growth in highway transport is continuous.

Although in many countries there have been already material changes, as time passes there will be a constant and profound readjustment in our economic and social structure because of the adaptation and expansion of highway transport.

U. S. Leads in Number of Motor Vehicles.—The present utilization of highway transport may be approximately measured by the number of vehicles in use in proportion to area and also population. In Table I is indicated the total number of motor vehicles by countries and the number of vehicles per square mile and per 1,000 population.

The United Kingdom of Great Britain leads in the number of vehicles per square mile, 16.2, and Belgium follows with 13.5. The United States of America is first in number of vehicles per 1,000 population, 217.5, and Canada follows with 123.3. At the other extreme the number of motor vehicles in proportion to area and population is so small that the influence upon the economic life of the nation is relatively nothing. This does not indicate that highway transport is non-existing or not required; rather it indicates the long struggle ahead of these nations to provide adequate highways.

Highway Expenditures Small Part of Total Expenses.—In the countries where highway transport has developed materially, the sums annually required for highway construction and maintenance are an important item of the annual governmental budgets. Taking the United States of America as an example of the nations in which highway transport has had a very large development, the annual budgets are shown in Table II. For the year 1930 the federal-government highway expenses totaled 2.19 per cent of the total federal budget receipts. The state expenditures for highways for the year 1929 were 21.3 per cent of the state budget receipts.

These percentages do not include the expenditures of municipalities or other governmental units smaller than the state for local roads. For many years these expenditures far exceeded the combined state and federal expenditures and now approximate them.

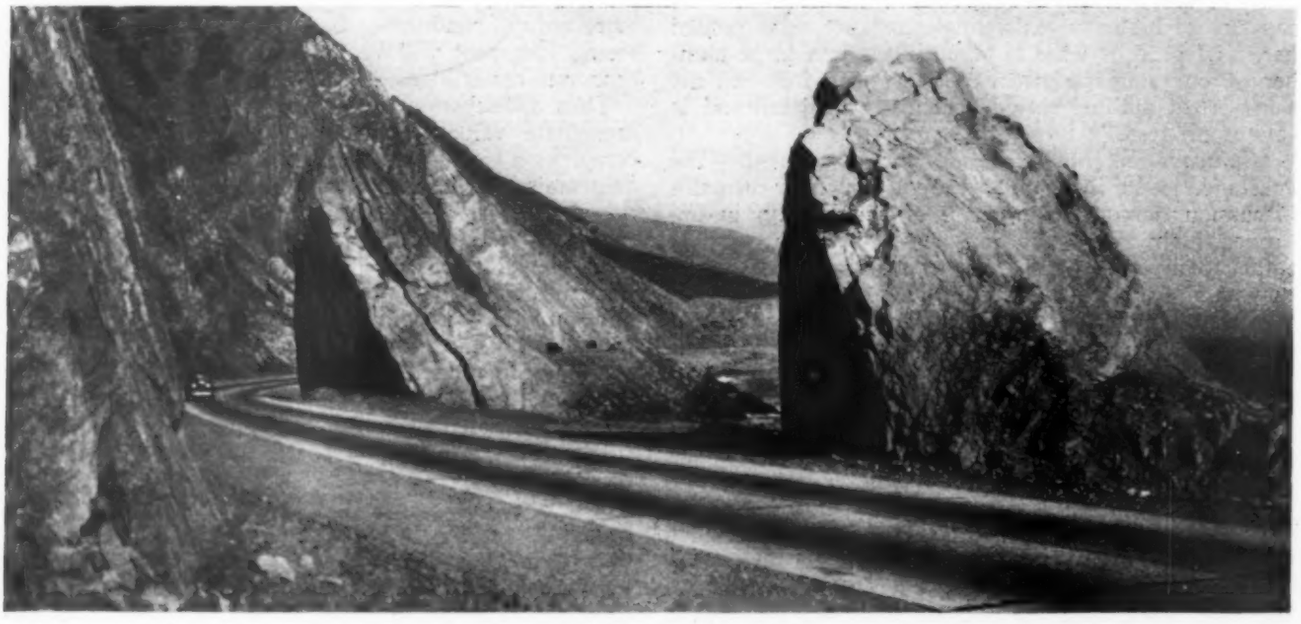
In some countries the local budgets for roads, other than streets in municipalities, are relatively small to the point of non-existence. In a few the total still exceeds the combined state and national budgets. These facts are only indicative of the extreme variations between countries and the utter futility of attempting comparisons or establishing like practices in countries. The financing of highways will always be a product of the economic structure of the country itself.

Principles of Highway Finance Outlined.—On the other hand, the general subject of highway finance with all of its ramifications has engaged the attention of representatives of national and international organizations for many years. From the periodic conferences and congresses has come a series of studies and conclusions that are beyond doubt expressive of international thought and experience. From these sources[1] a world-wide viewpoint is obtained.

It appears desirable to summarize briefly the principles expressed upon which there is apparently an international meeting of the minds of those who occupy positions of responsibility for and exercise authority over highway affairs in their respective countries. While, as indicated, wide differences in the economic structure and situations exist between the countries of the world, the same underlying principles are applicable to financial policies in all countries.

These are grouped with particular reference to their dominant motive or particular application, but summarized in brief form which fails to develop the shades of meaning which may be necessary for application to any particular country. Also conditions would vary so widely that it must be emphasized that many exceptions

[1]Conclusions upon Highway Finance:
5th International Road Congress, Milan, 1926.
6th International Road Congress, Washington, D. C., 1930.
1st Pan-American Road Congress, Buenos Aires, 1925.
2d Pan-American Road Congress, Rio de Janeiro, 1929.
Joint committee of American Association of State Highway Officials and U. S. Automobile Chamber of Commmerce.
16th annual meeting, American Association of State Highway Officials, 1930.
4th congress of International Chamber of Commerce, Stockholm, 1927.
5th congress of International Chamber of Commerce, Amsterdam, 1929.



A Concrete Road beside the Pacific in Southern California—on the New Roosevelt Coast Highway between Santa Monica and Oxnard

can be found in individual countries to the application of general financial principles.

Group 1—Administrative Policies Essential to Sound Financing.—Highways should be classified. Broadly the division is (a) general-use highways, (b) local-use highways. These two general classes may be subdivided. The general-use highways would include the roads which are necessary to the development of highway transportation and which are used by the general public. The local roads would include those whose principal use is by those living upon or contiguous to them. The basis of highway classification is a study of the present and potential use.

A highway budget should be established covering necessary expenditures over a period of years. The budget should be measured not only by the desirable program of construction and maintenance but by other relative needs for public expenditure.

TABLE I—RELATION OF MOTOR VEHICLES IN VARIOUS COUNTRIES OF THE WORLD TO THEIR AREA AND POPULATION AS OF JAN. 1, 1931

(Data on foreign census of motor vehicles from U. S. Department of Commerce)

In Order of Motor Vehicles	Name of Country	Number of Motor Vehicles	Ratios: Motor Vehicles per Sq. Mile	Ratios: Motor Vehicles per 1,000 Population
1	United States[1]	26,697,398	8.8	217.5
2	United Kingdom[2]	1,529,272	16.2	33.4
3	France	1,459,650	6.9	35.8
4	Canada	1,224,098	0.3	123.2
5	Germany	679,300	3.7	10.8
6	Australia	567,020	0.2	8.8
7	Argentina	366,324	0.3	33.6
8	Italy	293,215	2.4	7.1
9	Brazil	199,570	0.1	4.9
10	Spain	189,650	1.0	8.3
11	New Zealand	189,615	1.8	13.5
12	India	174,450	0.1	0.6
13	Union of South Africa	159,400	0.3	23.0
14	Belgium	158,986	13.5	19.9
15	Sweden	145,273	0.8	23.7
16	Holland	118,735	9.0	16.0
17	Denmark	110,324	6.5	32.1
18	Japan	95,719	0.4	1.1
19	Dutch East Indies	84,783	0.1	1.7
20	Switzerland	81,045	5.1	20.2
21	Mexico	80,801	0.1	4.9
22	Czechoslovakia	79,006	1.5	5.4
23	Algeria	50,250	0.2	8.4
24	Irish Free State	48,400	1.8	16.3
25	Hawaii	47,846	7.5	13.0
26	Uruguay	47,430	0.7	25.6
27	Norway	46,463	0.4	17.5
28	British Malaya	41,652	1.5	29.7
29	Poland	41,260	0.3	1.4
30	Cuba	41,222	0.9	11.4
31	Austria	39,209	1.2	5.9
32	Philippine Islands	37,049	0.3	2.9
33	Rumania	37,000	0.3	2.1
34	Chile	36,245	0.1	8.3
35	Finland	36,234	0.2	10.1
36	China	35,489	0.01	0.05
37	Egypt	32,627	0.1	2.3
38	Russia (U.S.S.R.)	30,910	0.004	0.2
39	Portugal	30,557	0.9	5.4
40	Ceylon	20,727	0.8	3.8
41	British East Africa	19,453	0.02	1.7
42	Hungary	19,333	0.5	2.2
43	Greece	19,250	0.4	3.1
44	French Indo-China	18,595	0.07	0.9
45	Venezuela	18,000	0.1	5.9

[1]Includes 173,619 official cars.

[2]United Kingdom of Great Britain, distributed as follows:

England	1,306,458	25.7	35.1
Scotland	124,098	4.1	25.4
Wales	64,177	8.6	28.9
North Ireland	27,035	5.2	21.5
Channel Islands	5,690	75.9	63.2
Isle of Man	1,814	8.0	30.2
Total	1,529,272	16.21	33.4

TABLE II—RELATION OF U. S. GOVERNMENT EXPENDITURES TO TOTAL RECEIPTS

Fiscal Year	Federal Budget Receipts	Highway Expenditures—Federal Aid, Forest Road and National Park	Per Cent Highway Expenditures to Total Receipts
1926	$3,962,755,690	$101,261,001	2.56
1927	4,129,394,441	94,917,218	2.29
1928	4,042,348,156	94,515,723	2.34
1929	4,033,250,225	97,433,182	2.42
1930	4,177,941,702	91,333,001	2.19

Receipts: Statistical Abstract of the United States, 1930, p. 171, Table 182; also World Almanac, p. 156 (U. S. Treasury figures).

Highway Expenditures: Federal-aid roads, U. S. Bureau of Public Roads; forest roads, U. S. Bureau of Public Roads and Forest Service; national parks and Mt. Vernon Memorial Highway, U. S. Bureau of Public Roads.

TABLE III—RELATION OF STATE HIGHWAY DISBURSEMENTS TO TOTAL STATE FUNDS AVAILABLE

Fiscal Year	State Budget Receipts	Highways—State Disbursements	Per Cent Highway to All State
1926	$3,288,904,527	$621,744,210	18.9
1927	3,548,465,739	707,179,148	19.9
1928	3,880,078,608	827,549,983	21.3
1929	4,274,318,100	910,485,291	21.3
1930			

Source: Financial Statistics of States (1926-1928), Table 2—Total Receipts (aggregate of receipts and cash on hand).

Group 2—Sources and Disposition of Highway Revenues.—The cost of the highway program should be distributed equitably in relation to the direct and indirect benefits to the various classes of persons or property benefited, taking into consideration the capacity of each class to pay, and the other taxes imposed. The principal sources of revenue are the following:

1. General taxes on property, which should be conserved so far as possible for the development of local roads.

2. Assessments for special benefits to property not to be used generally but in specific cases, and in proportion to special benefits arising through road improvement.

3. Road-user taxes including license fees and fuel taxes not exceeding a fair burden upon the highway user or the point of diminishing returns. The income from these taxes is to be used first for systematic maintenance of general-use highways, and the additional amounts for construction of the general-use highways or for the retiring of principal and interest of bonds for this purpose. All road-user taxes except necessary administrative expenses should be set aside and used solely for highway purposes. These taxes should be levied, collected and expended by a major governmental agency, either state or national.

4. Miscellaneous highway income. This principally includes appropriations made from general revenues; also any other special revenues made available for road purposes.

Group 3—Organization and Control.—Each major unit of government should maintain an adequate highway organization of trained technical personnel continued in office during competent service under civil service or similar fixed policy.

Each major organization must have sufficient direct or supervisory control over the road program to insure direction of expenditure to the improvement of roads in the order of their importance to the public, and to secure

the objective of a unified system or systems where different parts are built under control of the component divisions of government. Financial assistance extended by the state and nation to the next order of governmental divisions is an effective method of securing important objectives. Thus, national aid extended to the states provides a continuity of major highways between states and secures a correlated national system of highways; and state aid extended to the counties secures a desirable measure of supervision of the technical standards and a selection of improvement best calculated to supplement the state road system. This plan may be used to secure a more equitable distribution of costs between the divisions of government and sources of revenue.

Group 4—Anticipation of Revenues. — The anticipation of road revenues through bond issues for expediting improvement of general use highways is sound if properly administered under competent management, and if the amount of the bonds issued bears a conservative relation to the assured income.

Group 5—Construction and Maintenance Programs. —Adequate maintenance costs should be regarded as a first obligation upon road revenues, and the balance of the income available for new construction should be used for improvement of a class or type justified by the potential earning capacity of the highway.

The Two General Classes of Rural Roads.—Because of the competitive condition which has developed in this country between different forms of transportation, one phase of highway finance may be properly touched upon in an international meeting, since this same situation exists in greater or less degree in some of the other countries.

There are two general classes of rural highways, state and local roads. Federal financial assistance is extended to a portion of the state roads, which comprise in excess of 300,000 miles. Federal aid is limited in its application to about two-thirds of this mileage. While the local roads in the aggregate include about 2,700,000 miles, the competition which exists between rail and highway transport is confined almost wholly to the state systems. Those systems taken as a whole cover the United States with a network of highways reaching every important city and town, and furnish the routes for all principal intrastate as well as interstate highway traffic movement.

There is a very small amount, if any, of private-car, motor-bus or motor-truck operations which is competitive in any way with the steam railroads on other than the state systems. Since these comprise the highways of general use, the roaduser taxes have been largely devoted to their construction and maintenance.

Two policies have been followed. In some states the annual total of road-user taxes has been expended, first, for maintenance, and second, to carry on as large a program as possible of new construction. In many other states, after deducting maintenance requirements, a considerable portion of the balance is being used to pay the interest and retire the principal of bonds issued in anticipation of these revenues. Any remaining balance is used for new construction.

There have been no bond issues in recent years of any considerable size for state road purposes which were not predicated upon the road-user taxes. If, therefore, the total expenditure for state highways is considered for the past ten years, the percentage of this total supported by the road-user taxes shows a steady and large increase.

Road-user Taxes Amounted to 78 Per Cent of Total Expenditure.—The total disbursements by the states for state highways in 1929 were $864,000,000. The income from the motor-vehicle fees and the gasoline taxes for the same year devoted to this purpose was $565,000,000. The bonds issued in anticipation of the road-user taxes amounted to $114,000,000 of the total disbursement, bringing the percentage of total expenditure supported by the road-user taxes to 78 per cent.

The tendency is growing rapidly toward the elimination of all general property taxes by the states in supporting the state road program, and any taxes levied upon the railroads and used for this purpose can be dispensed with without impairing the ability of the states as a whole to carry on an adequate state highway program.

The Financing of Local Roads.—The local roads can-

A New Mexico Federal-Aid Project—Blading an Oil-Mix Road during the Compaction Stage

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One of the Country's Beautiful Bridges, Carrying an Important New Jersey Highway over the Raritan River

not fairly be brought into any discussion of competition between rail and highway transport, since the rail movement is from station to station, and highway movements between towns and cities are almost exclusively over the state highways.

In 1929 approximately $750,000,000 was spent for the improvement of local roads, exclusive of city streets. Road-user taxes to the extent of $122,000,000 were used for these roads, or about 16 per cent, plus the bond issues used for this purpose supported from the user taxes.

The only question that would seem to be reasonably germane to the matter of expenditures for local roads is whether the taxes paid by the railroads which are used in any measure for this purpose are fair or unfair; that is, this is not a question between the road-user taxes and railroad taxes. The matter of fairness of any taxes levied upon the railroads for the development of local roads can never be determined so long as taxing authority over the railroads is distributed among so many taxing bodies.

In the highway field it has been a strong contention that the user taxes should be levied, collected and expended under the direction of the state, and this would seem to be a reasonable plan to follow in considering any measures of relief for taxation of the railroads. In this connection, there has been a tendency to total highway expenditures for both state and local roads, and consider the road-user taxes in relation to the whole. There is a vast mileage of public roads and streets whose only service is to the land, whether it be used for any character of agriculture and other purposes, or in cities for residential areas. On these there is no general flow of highway traffic. Their improvement certainly cannot be made a fair charge against the road user.

The adjustment between state and local roads is rapidly taking place in two ways: (1) by an absorption of the more important local roads into the state systems, there to be financed in large part by the user taxes; and (2) by the allocation of a goodly percentage of the user taxes for the use of the local roads. This adjustment is taking place continuously, so that each year will show an increasing percentage of the total cost of all roads of general use paid from the user taxes.

These observations are not intended to be conclusive, but rather indicative of the desirability of a more careful study and a more complete understanding of the existing facts, and the trends of highway financing, especially as it relates to the conflicts between transportation agencies. Certainly every effort should be made to bring about relative fairness in all matters vitally affecting the different types of transportation.

Acknowledgement.—The foregoing is a paper presented May 5 before the Committee on Highway Transport at the 6th general congress of the International Chamber of Commerce.

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Quality of Structural Concrete in Missouri Reported Improved

Concrete placed in structures of the Missouri State Highway Commission has recently shown a decided improvement in quality, according to D. B. Levi, engineer of construction, who writes in the *Construction Adviser* as follows:

We are very much gratified by the reports of marked improvements in the quality and strength of structural concrete, particularly that placed under winter conditions. The inspections and records of the bureau of bridges corroborate our observations. Also very satisfactory test reports have been coming from the testing department on structural concrete placed during the winter season.

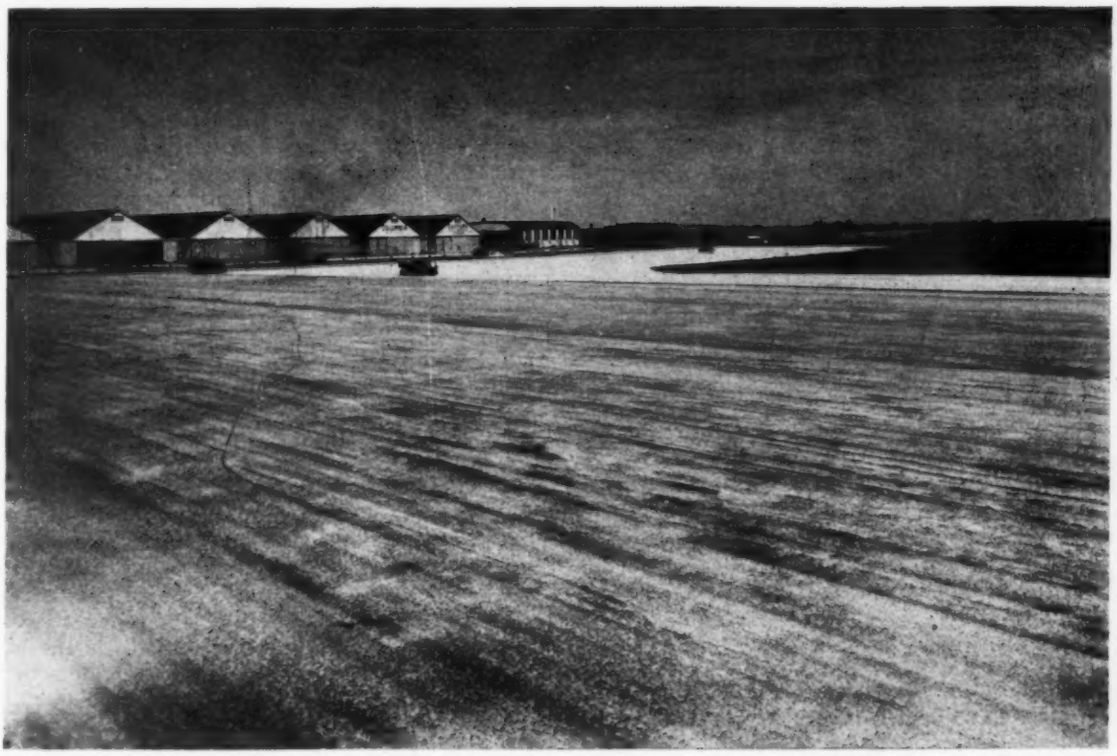
In practically all cases the tests indicate strengths well above our requirements and exceeding the results often secured in cold weather concreting of previous years.

Probably this is due to several factors. The 1930 specifications added somewhat to the requirements for heating of materials and proper protection after pouring, the winter season has been unsually mild and inspectors are paying more attention to the quality of the finished concrete.

The OLD *and the* NEW

. . . Bridge History on a Missouri Highway . . .

A RELIC out of the past and a modern structure built to replace it are contrasted in these two pictures taken on the St. Louis-Kansas City highway about 7 miles west of Columbia, Mo. The covered bridge is of unknown age, but it is believed to be from 75 to 100 years old. The modern steel bridge was built about three years ago, a little below the older structure.



Runways at Roosevelt Field, L. I. Section in Foreground Complete Except for Final Seal Coat; Crushed Limestone Wearing Course Being Rolled in Background

Bituminous Surfaces *for* Airports

By COL. H. L. BOWLBY
General Manager, Colas Roads, Inc.

SATISFACTORY taking-off and landing surfaces for airports is a subject of considerable interest. A great deal of attention has been given this problem during the past few years and there is yet much difference of opinion as to the best layout for an airport and as to the most suitable surfaces for its runways, taxiways, etc. Much useful research work has been done by the U. S. Department of Commerce, the Aeronautical Chamber of Commerce and by various committees that have been investigating the subject.

Those who have had an opportunity of seeing the invaluable bulletins circulated by the aeronautical branch of the U. S. Chamber of Commerce, giving in detail the facilities and the layouts of airports in all parts of the country, will realize the widely varying local conditions that prevail. The surfacing of airports divides itself into two parts: (1) the general design or layout of the airport and (2) the nature of the field surfaces required.

Principles of Design.—The U. S. Department of Commerce has made certain regulations as to the essential requirements of an airport and it has established a system for rating those airports that conform to certain standards of safety. Already, there are over 2,000 airports in this country and the development that is taking place in providing safe landing fields is proceeding at a fast pace. The need for controlling the design and construction of these airports is, therefore, very important. The minimum requirements call for a firm level field of sufficient size and free from both ground and overhead obstructions, and having a suitable highway connection. The equipment must include a wind-direction marker and, in the center of the field, a white circle 100 ft. in diameter; there must also be facilities for refueling and for making minor repairs to airplanes. The area required is dependent upon the elevation of the airport above sea level. The U. S. Department of Commerce specifies a clear run of not less than 2,500 ft. at sea level, while at 5,000 ft. elevation this is increased to 4,000 ft.

Layout of Runways.—The prevailing practice at airports having more than just intermittent use is to provide at least one and often several runways for the purpose of taking-off and optionally for landing. In the layout of these runways no two airports seem to be alike and at many of them their suitability and adequacy are certainly open to criticism.

It may not be very long before some of our airports are completely paved but for the present a properly designed system of runways will handle the airplane traffic expediently and with safety. The direction of the prevailing wind provides the basis for the layout of an airport. A runway, connected by an apron to the hangars, is located into the direction of the prevailing wind. This is usually supplemented by other runways laid out at angles to it and in such directions as to conform as nearly as possible to the local average wind conditions. At airports having more than intermittent

traffic the runways should permit the landing of planes on separate areas to those used in taking-off. In addition, taxiways should be provided to enable planes to make their ground movements without menacing planes that are taking-off or landing.

As to the dimensions of runways, their length is dependent upon the size of the planes using them and upon the elevation of the airport above sea level. A distance of 1,500 to 2,500 ft. will give ample length of paving for runways at most airports and a good width is 150 ft.

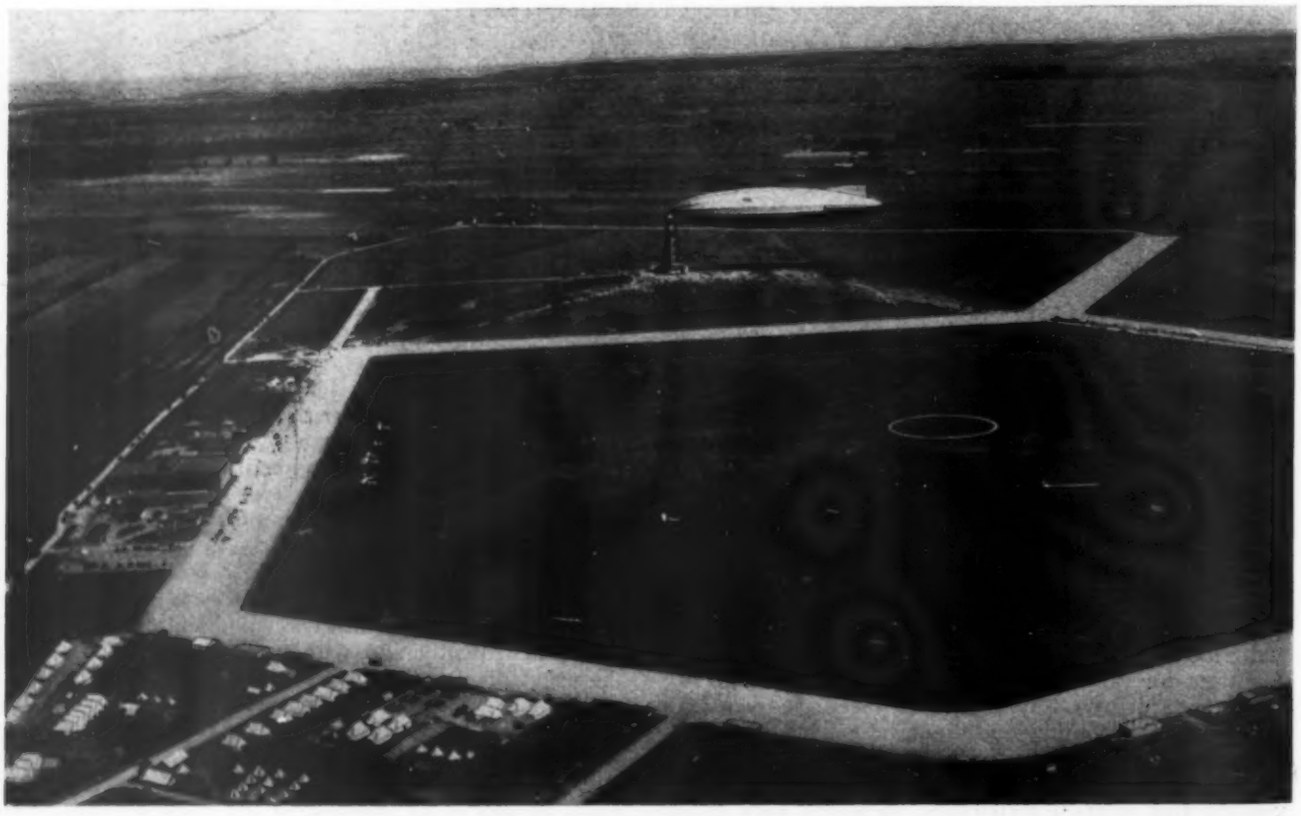
Drainage.—It is impossible in the scope of a short paper to deal conclusively with the problem of drainage. It is a matter which calls for close study in designing the layout of an airport, and an adequate expenditure on drainage will prove an economy in the long run. A careful preliminary survey of local conditions is necessary and it is advisable that analyses be made of the soil to ascertain its characteristics. Will it retain water or permit its percolation through it? It is most important that the drainage system be designed by fully competent engineers experienced in this class of work. Drainage is of primary importance at an airport just as it is with all important engineering work. The drainage system is dependent upon the contour and nature of the surface, the analysis of the soil, the extent of the rainfall and the amount of surface water to be disposed of. The drains can be laid in conformity with the natural contour of the field, or a gridiron or herringbone system may be desirable. The small lateral drains are laid at a depth of from 2 to 3 ft. and usually consist of clay or concrete tiles; the trenches are backfilled with screened clinker cinders, crushed rock or gravel.

For the mains, or sub-mains, either perforated corrugated galvanized-iron pipe or uncalked sewer pipe is used. Open drains and ditches are, of course, to be discouraged because of the ground hazard.

Airport safely depends upon proper airport drainage. Inadequate drainage causes soft and marshy surfaces and pilots do not hesitate to avoid such fields. Paved runways tend to increase the drainage problem as such areas are largely, if not entirely, waterproof and a heavy rainfall on several acres of surfacing represents a surprisingly large volume of water. Ample outlets for the drainage mains are consequently necessary to take care of this storm water. It is usual practice to provide french drains backfilled with clinker cinders, gravel or broken stone along the edges of the runways. These drains are made 24 in. in depth and are often provided with a 6-in. drain tile at the bottom of the trench. The upper 3 in. of this trench is backfilled with clean, coarse stone. At some airports these surface stones are whitened, making the runways stand out more clearly from the air.

The Surfacing Problem.—The selection of the most suitable type of runway surfacing is not an easy matter. It is quite a different problem from that of surfacing a road. An airport runway has no regular "traffic" on any one part of its surface; while with a road, practically the whole surface is continually under the rolling and consolidating action of motor vehicles. Also with a large expanse of surface area there is the absence of the lateral support given by the shoulders or curbs of a road.

Then there is the question of strength of the pavement chosen for the runway. The weight of a large passenger or freight plane is no small matter. This weight is constantly increasing, making impact loads greater as time goes on. The weight of a 32-passenger plane now being used amounts to 32,000 lb. on a two-wheel landing gear. It can easily be seen that the landing of such a plane imposes a very severe shock on the runway surface. Similarly, with smaller planes there is



Airview of St. Hubert Airport

Runway Construction at St. Hubert Airport, Montreal, Canada

a tendency to increase the wing loading which also means an increase in landing speeds.

For instance, a fast monoplane now achieving popularity has a total weight of 4,500 lb. with only 275 sq. ft. of wing surface, or a wing load of 16 lb. per sq. ft. of wing surface. Under the most favorable conditions, an airplane of this type will touch the ground at 75 to 80 m.p.h. The impact load per square inch, with 32x6-in. tires, is therefore considerable.

Type of Surface Required.—Of the various requirements of a runway pavement it is in the first place essential that it shall be smooth and yet "non-skid." It must be sufficiently durable to withstand the weight and impact of traffic imposed upon it and it must be free from dust or loose stone chips. It is desirable that it be waterproof and adequately drained. It is necessary that the surface can be readily seen from the air. Last, but by no means least in importance, the construction cost and the maintenance cost must be low.

Types of Surface Available.—Until quite recently, few airports had any real alternatives to grass or turf and, while in temperate climates this is still the principal wearing surface, it is quite inadequate on such areas of an airport where planes are frequently taking-off and landing. Those who have seen a dry turf field in the summer, when it is shrouded to a considerable height in the air in a cloud of dust, will realize the importance of providing a more permanent and less dangerous pavement. Similarly, a turf landing surface, unless it is particularly well drained, may always constitute a source of danger during wet weather and particularly to the larger sizes of aircraft.

In less temperate climates, where turf is not dependable, gravel, sand and clay are often used, either separately or in combination; but treatment with oil or calcium chloride is necessary in hot weather. If the airport is used by more than a few planes daily, at least one paved runway will be necessary. It is impossible to recommend any one "best" type of runway pavement. The amount of wear to which the surface is subjected, the funds available, the climatic conditions, the nearest source of road-building material, are all factors that influence the selection of the proper type. The thickness of surface laid is largely dependent upon the foundation. If the base is poor and lacking in stability then a 1 or 2-in. thickness of pavement is insufficient.

Quite a number of airports have adopted an inexpensive light crust construction but this can only be false economy when the surface is carrying weights of 20,000 lb. and more moving at 70 to 80 m.p.h., in addition to the impact of landing. We would not think of building a road in this way for loads of this weight.

While it is extensively used for hangar floors, and aprons, cement concrete does not appear to be as popular for runways. Concrete has the appearance of hardness and although this may not affect the safety factor, it may set up what may be termed a mental hazard.

Various types of asphalt construction have been relied upon. It has been generally found that a bituminous binder properly adapted to a local mineral aggregate will satisfactorily fulfill the essential requirements that have been detailed.

Asphaltic Concrete.—The use of asphaltic concrete is sometimes favored and it provides an excellent surface. If it is laid to a depth of 1½ or 2 in. it is important that the base be a substantial one. It is advisable that the base be either a crushed-rock course penetrated with asphalt or a 5-in. thickness of cement concrete. Such a pavement will give excellent results although its cost requires careful consideration.

The Oil-Earth Mix Process.—At a number of airports, a treatment comprising the mixing of the earth or sand surface with an asphaltic oil has been adopted. This is known as the Glendale method, so named from its use at the Grand Central Air Terminal, in Glendale, Calif., near Los Angeles. The method comprises the mixing-in-place of the existing surface or of a sand course with a suitable asphaltic oil.

For successful results, it is necessary that the surface material should be a coarse sand and practically free from loam or clay. The soil should be analyzed. After the ground has been leveled, it is disc-harrowed to a depth of approximately 6 in. The asphaltic oil is then applied, using up to 3 gal. per sq. yd. This quantity of oil is sprayed in a number of applications and the surface is thoroughly disc-harrowed between each application. The mixing can also be assisted by the use of blade graders which, by repeatedly turning the mixture over, secure thorough impregnation of the material with the oil. When the mixing is completed, the surface is dragged smooth with wooden box drags. The surface is then lightly rolled.

Emulsified Asphalt.—One of the most interesting developments in present day road construction is the development of a quick-breaking asphalt emulsion. One of the principal advantages of this method, from the point of view of airport construction, is that it enables a wide range of materials, especially local sand and

gravel, to be used which would not otherwise be suitable for use in hot binders.

Notable examples of emulsified-asphalt construction are to be found at Roosevelt Field, Long Island, and at St. Hubert Airport, Montreal. Roosevelt Field affords an interesting example of economical construction with local materials. This airport comprises two all-way flying fields with a total area of approximately 700 acres. The west field, on which surfacing has been provided, carries the greater proportion of the traffic. The west field comprises accommodation for 31 hangars which are, roughly speaking, located on two sides of a square. The subsoil of the field is of sandy gravel but the dust in the summer and the mud and slush in the winter had made flying conditions unpleasant and often dangerous. It was decided to surface an area in the form of a segmented triangle, the apex of this triangle being at the angle of the two lines of hangars.

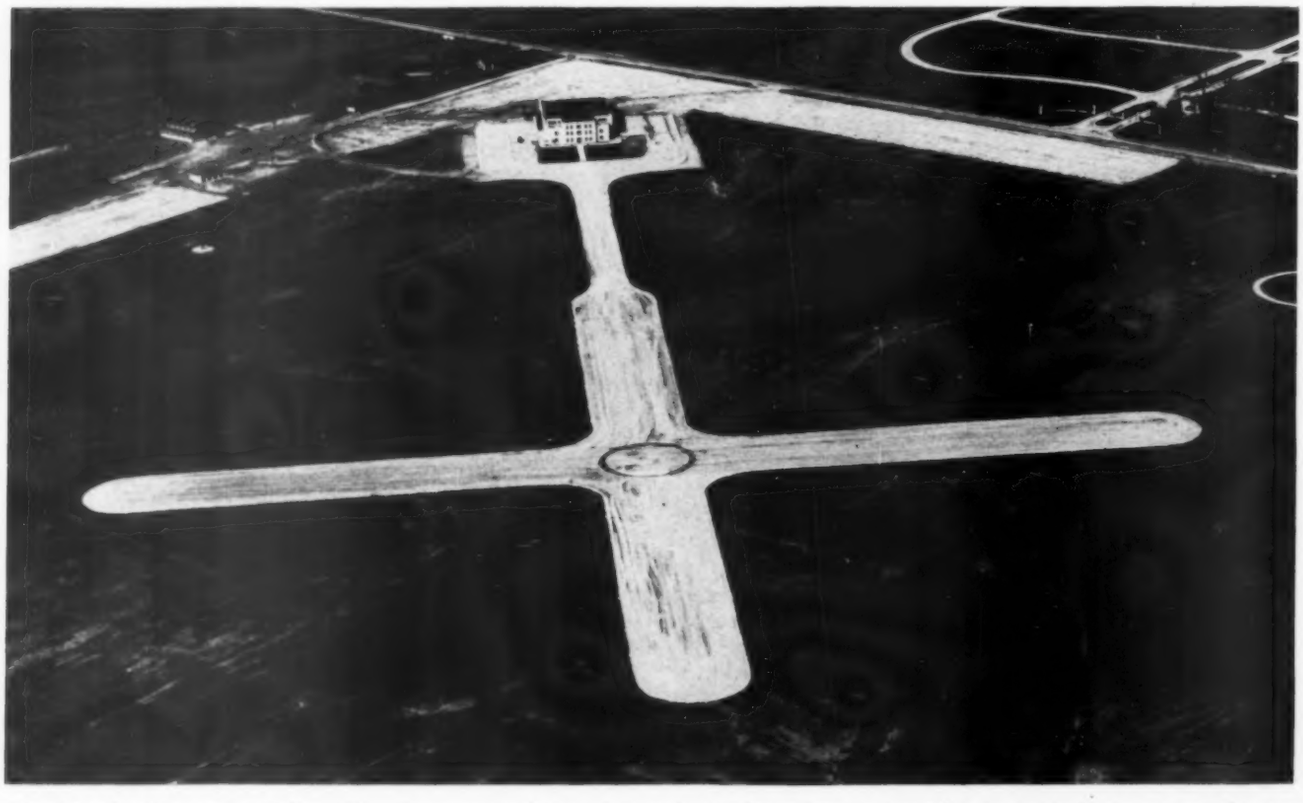
The base of the triangle forms a runway 100 ft. wide and 1,800 ft. in length. The two sides of the triangle form an extension to the existing concrete aprons and are 150 ft. wide. Two runways are laid out from the angle at the apex of the triangle to the runway at the base of the triangle. The total area surfaced is equivalent to 70,000 sq. yd.

At one side of the field it was found that the subsoil comprised a mixture of 50 per cent coarse sand and 50 per cent gravel, the mixture being almost entirely free from clay. It was decided to make use of this material for the base coarse of the runways and to bind it with a quick-breaking pure asphalt emulsion.

After the existing surface had been excavated and rolled to the required elevation, the sand-gravel mixture was spread from trucks to a depth of approximately 2 in. The asphalt emulsion was then applied under pressure from a 1,200-gal. distributor truck at the rate of approximately ½ gal. per sq. yd. Two agricultural spike-toothed harrows were attached to and dragged behind the tank truck, these serving to mix the gravel with the emulsion. After 3 to 4 hours had elapsed, the surface was rolled with 8-ton tandem rollers. Another 2-in. course of gravel was then spread, treated and rolled in the same way. The purpose of this 4-in. sand-gravel course, containing approximately 1 gal. of emulsion per sq. yd., was to furnish an inexpensive yet stable base for the wearing surface course.

On this prepared base a layer of crushed limestone (dolomite) was spread in sufficient quantity to provide a 2-in. wearing surface on completion. This stone was graded from 1½ to ¾ in. and care was taken to prevent the loaded trucks from running on to the prepared base. The crushed limestone was carefully leveled up by the use of a blade grader and rolled with 8-ton tandem rollers. When this layer of broken stone was firm under the roller the entire area was scarified with a spike-toothed harrow drawn by a track-type tractor. The object of this harrowing was to remove all minor undulations from the runway surface. The surface voids were then choked up with ½-in. screened gravel and the rolling continued until no further movement took place. Asphalt emulsion was then applied by pressure distributor trucks at the rate of 1½ gal. per sq. yd. The surface was immediately covered with a light application of ⅜-in. gravel chips and rolled. A second application of ½ gal. of emulsion per sq. yd. was made and covered with ⅜-in. gravel chips. The surface was again thoroughly rolled. During the rolling the gravel chips were swept about over the surface by means of rattan street brooms. A final finish was given to the surface by a seal coat of emulsion at the rate of 1 gal. to 5 sq. yd. No cover material was used with this seal coat but the surface was again rolled, the rolls being kept damp with water. The resulting runway surface is a smooth, non-skid pavement that is absolutely dustless.

This specification has provided runways at a low cost



Municipal Airport at Joliet, Ill., Runways of Local Crushed Limestone; Emulsified Asphalt Used as Binder

Roosevelt Field, L. I., November, 1930. Runways Constructed of Local Aggregate; Emulsified Asphalt Used as Binder. Dustless Finish Given by Final Seal Coat of 1/5 Gal. of Emulsion per Sq. Yd. No Cover Material Used

that have the necessary characteristics of an ideal airport surface. They have a reasonably long life without maintenance, they are comparatively resilient and they are unaffected by extremes of temperature and weather. They completly eliminate the dust nuisance and they provide both a safe landing and a good take-off.

The surfacing of the St. Hubert Airport at Montreal comprised the paving of six runways, each 150 ft. wide by approximately 2,000 ft. in length, joined in the form of a hexagon with a seventh runway in the direction of the prevailing wind. The runways were built of a 6-in. sub-base of gravel, a 4-in. course of 4-in. limestone and a 3-in. wearing surface of asphalt-emulsion-penetrated limestone. The final finish of these runways consists of a seal coat of emulsion and a covering of limestone chips; this has given the paved areas a light-colored finish which illuminates well at night.

It is interesting to record that, whereas the pilots at this airport have the alternative of landing on or taking-off from a good turf surface, the paved runways are invariably used.

The under-drainage of the St. Hubert Airport proved to be a considerable undertaking. The flat nature of the ground necessitated a large expenditure for drainage to dispose of excess rain water. Cross-tiling was placed under the runways, using 6-in. tile, and additional broken-stone drains were added where needed. These cross-tiles were connected with longitudinal drains, placed parallel to and on both sides of the runways under the shoulders for their full length. These were connected with large concrete draining wells at convenient points, which, in turn, were connected with larger drains, conveying the water out to deep ditches. The use of the draining-wells system enables the engineers to ascertain whether the draining system is working properly.

All the runways at St. Hubert Airport were given a crown of ⅛ in. per ft. In the case of Roosevelt Field the paved areas were provided with a slight transverse slope of approximately 3 in. in 100 ft.

Whereas the cold-penetration method was used in the cases of both Roosevelt Field and St. Hubert, it is possible by the use of emulsified asphalt to adopt other methods for incorporating the asphaltic binder with the mineral aggregate. With certain aggregates the premix or mixed-in-place methods may be preferable to the penetration method. At the Croydon Air Terminal, England, the areas adjacent to the concrete aprons have been paved by mixing-in-place the existing earth surface with asphalt emulsion of a special grade. In this case the work was completed with two seal coats of emulsion and pea gravel, thereby providing a hard finish which is said to be proof against tail skids. This surface is carrying heavy freight and passenger traffic and although the paving has not yet been in use long enough to report authoritatively, the low cost of the work combined with the good results to date indicates that this method which was used at Croydon may have a future.

Many of our airports are becoming overcrowded and there are far too few airports near the larger cities with sufficient area of runway pavement. With every progressive city, money properly spent on local airport development is bound to be money well spent because of the immediate favorable effect on this newest method of transportation.

In conclusion, one cannot do better than quote the recommendations of the Aeronautical Chamber of Commerce, "In planning airport development, make a thorough and complete study of all conditions, secure competent engineers and reliable and experienced contractors, and at a reasonable cost the result will be a dependable, safe landing area at all times."

Steaming Rock Asphalt in Winter Work

By Fred Gesling
Consulting Engineer, Ashland, Ky.

In order to speed construction of the Kyrock top on the boulevard around the Morehead State Teachers' College, at Morehead, Ky., it was found necessary to restore the material to a friable state by steaming. This material works easily in ordinary summer weather. At temperatures below 50 deg. the bitumen congeals and the material becomes difficult to unload and lay.

Steaming, within proper limits, reduced the material to ideal working consistency and permits construction to proceed successfully in very low temperatures. A dry steam is essential. A pressure of 100 lb. at the boiler is necessary to secure it, and a minimum of 40 hp. for each car heating. Allowable temperatures for steaming range between 250 deg. maximum and 150 deg. minimum.

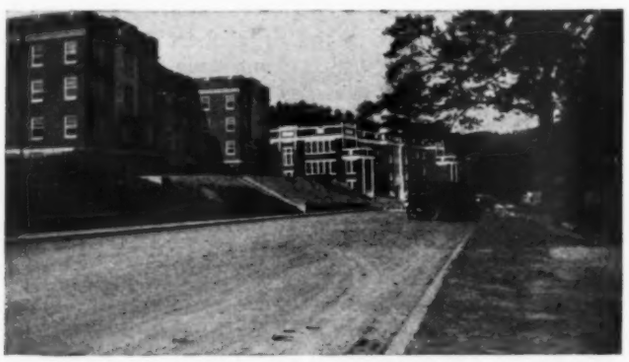
A local ice plant in Morehead, with side track, provided convenient facilities for our work. A 2-in. main line was extended from their boiler and eight jets were sunk into each car of material, as shown in the accompanying illustration. The jets were constructed of ½-in. pipe 5 ft. long, connected to the main line with steam hose and provided with a valve for regulating. The jets were inserted in the material and easily forced through to the bottom of the car. Steam was then turned on full force and each car steamed from 2½ to 3 hours. The material was then unloaded into trucks, hauled under tarpaulins and dumped directly on to the concrete base which had previously been sprayed with a cut-back asphalt paint.

Steel strips ¼x2¼ in. in section and 18 ft. long, with a 12-in. section at one end bent into a tee to prevent overturning, and laid edgewise on 3-ft. centers parallel to the center-line, served as depth gauges. Triangular wooden lutes, operated back and forth over these strips, raked the loose material to the proper depth, as shown in the accompanying illustration. As the base was constructed with integral curbs, no forms on the sides were necessary. The depth gauges are pulled forward as the job progresses.

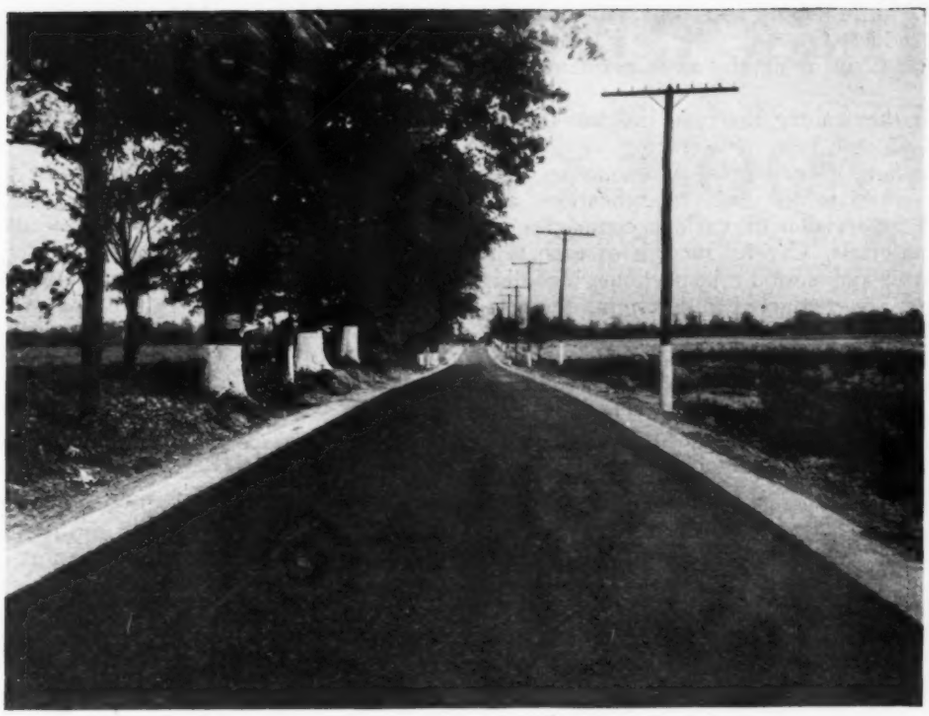
The steaming operation reduced the material to the consistency of heavy brown sugar and greatly facilitated the work of unloading and raking, permitting a degree of speed in these operations which completed the job in record time. Following the rakers a 3x3-in. float 8 ft. long, with a long handle, was operated at 45 and 90 deg. to the center-line to correct the slight irregularities left by the rakers. An 8-ton tandem roller followed closely behind the spreading crew and compacted the material while warm. This method produced an unusually smooth-riding surface. Traffic was turned on to the surface immediately after rolling.

The contractor was F. T. Justice & Co., of Lexington, Ky. Complete specifications called for a 6-in. concrete base of 1:2½:5 mix, 42 ft. wide with 6-in. integral curbs and a 1½-in. (compacted) Kyrock wearing surface. This boulevard connects with the Midland Trail, U. S. Route 60.

Left—Steaming Layout Laid on Top of Car, Ready for Heating Rock Asphalt. Right — Start of Spreading, Showing Operation of Lutes. Note Smoothness of Material



Left—Surface Material Raked to Grade and Ready for Rolling. The Material Compacts About One-Third under the Roller. Right—Surface Opened to Traffic



A Section of the Maryland Experimental Road, Showing 16-Ft. Bituminous Surface with Two 24-In. Concrete Headers

The Maryland Test Road

Fourteen types of material used in resurfacing 4½-mile section of old Annapolis Road — Careful records being kept — Experiment attracting much interest

By C. N. CONNER
Associate Editor

THE state of Maryland was among the first in the United States to undertake the construction of concrete roads. The result is that today there are some highways of this type on the system built 15 or 18 years ago under specifications adequate at the time, but long since obsolete. While the value of such roads from the standpoint of wearing surface is considerably reduced, they are entirely adequate as a base on which to place the proper type of surfacing. In order to determine their relative merits the State Roads Commission decided to construct test sections of a number of the various types of resurfacing materials before permitting their use on state road contracts.

The Experimental Section.—In April, 1930, the old Annapolis Road between Sweetzer's Bridge and Glen Burnie, a distance of approximately 4½ miles, was selected to be resurfaced as an experimental section. This road was originally built in 1915 and 1917 of concrete 16 ft. wide, 5 in. in depth at the edges and 7 in. in depth at the center. Fourteen different experimental types of resurfacing were selected and laid on this road, each section being approximately 1,700 ft. in length. In order to obtain additional width of roadway, a concrete shoulder 2 ft. wide and 8 in. in depth was constructed along each edge of the existing pavement and raised from 1½ to 3 in., so as to provide a header for the several varying depths of resurfacing materials. On the section which was resurfaced with concrete, a widening of similar width and depth was included as a part of the resurfacing and poured at the same time.

Types of Resurfacing.—The types of resurfacing materials used were as follows:

1. Concrete resurfacing (4 in. in depth) as recommended by the Portland Cement Association.
2. Asphalt penetration macadam (3 in. in depth) as recommended by the Barber Asphalt Co.
3, Bitumuls (2 in. in depth) as recommended by the American Bitumuls Co.
4. Amiesite (2 in. in depth) as recommended by the Interstate Amiesite Co.
5. Colprovia (2 in. in depth) as recommended by Colprovia Roads, Inc.
6. Bituminous concrete (2 in. in depth), State Roads Commission specifications.
7. Macasphalt (1½ in. in depth) as recommended by the Macasphalt Corp. of America.
8. Asbestophalt (1½ in. in depth) as recommended by the Warren Brothers Road Co.
9. Westphalt (1½ in. in depth) as recommended by the Westphalt Co. of Pennsylvania.
10. Bituroc (1½ in. in depth) as recommended by the Ohio Valley Rock Asphalt Co.
11. Kyrock (1½ in. in depth) as recommended by the Kentucky Rock Asphalt Co.
12. Slagmac (2 in. in depth) as recommended by the Standard Slag Co.

13. Tarmac (2 in. in depth) as recommended by the American Tar Products Co.

14. Tarvialithic (2 in. in depth) as recommended by the Barrett Co.

Appropriate markers along the road indicate the beginning and end of each type of surfacing.

Periodic Inspections Conducted.—All of these types were laid at cost and to the exact specifications and under the direct supervision of various companies interested in the materials. Careful records of each type have been prepared and periodic inspections, including roughometer tests, are conducted to determine the relative value of the materials and their costs of maintenance. Although it will probably take from three to five years to reach any definite conclusions, the experiment is today attracting much interest. The surfacing was completed and the road opened for traffic on July 6, 1930, and already it has been visited by road engineers from various parts of the United States, Mexico, Costa Rica, Australia and China.

The Maryland State Roads Commission is under the direction of C. Clinton Uhl, chairman. Engineering is directed by Harry D. Williar, Jr., chief engineer, and R. M. Reindollar, assistant chief engineer.

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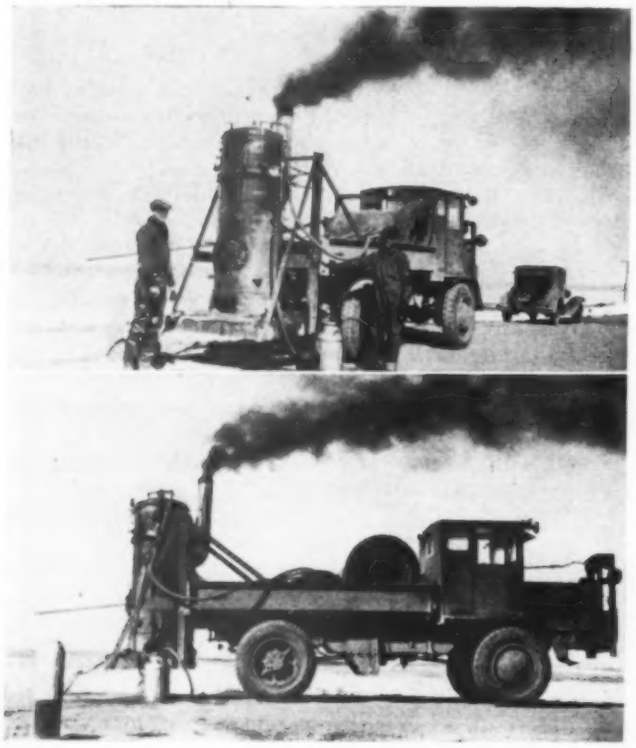
Thawing Frozen Culverts

By Harris Robinson

Assistant Division Engineer, Maintenance, North Dakota State Highway Department, Bismarck, N. D.

The equipment pictured herein is used by the Bismarck division of the North Dakota State Highway Department for thawing frozen culverts. Frequently in late winter or nearly spring intermittent thawing and freezing weather causes many culverts to freeze full of ice. With a steam boiler mounted on a truck, these frozen culverts can be readily opened. In this particular instance a 10-hp. Lookout vertical tubeless boiler is mounted on a 3-ton truck, a special steel frame or carriage being used to suspend the boiler as low as possible from the rear of the truck. This frame is so constructed that only two bolts are necessary in attaching it to the truck, thus making it readily removed when the truck is wanted for other jobs.



Two Views of Culvert-Thawing Outfit of North Dakota State Highway Department

In thawing culverts, up to 100 lb. of steam is carried in the boiler. A steam hose leads the steam from the boiler to a ¾-in. pipe which is forced through culverts by hand as the steam thaws the ice ahead of it. With a full head of steam a culvert can be opened in a few mintues. Because of the mobility of the outfit, many culverts can be cleared in a day.

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Dust Elimination in California

Dust elimination on California roads—a service rendered on 1,148 miles of road during the 1930 season—is described in the 7th biennial report of the California Division of Highways in the following paragraphs.

The present method involves the application of fuel oils containing 50 to 70 per cent of 80 penetration asphalt, the amount applied and preparation of the base being largely determined by the type of soil and volume of traffic.

Heavy clays not previously treated are swept free of dust with a power broom and the sweepings windrowed at the sides. Fuel oil containing 50 to 60 per cent of 80 penetration asphalt is then applied with a power distributor, either in one application at the rate ½ gal. per sq. yd. or two successive applications of ¼ gal. each and immediately covered with the roadside sweepings. If previously treated, the oil cake is scarified and windrowed at the sides for covering the oil application. Where traffic can be detoured better results are assured if the cover is omitted and the oil allowed to penetrate the base thoroughly.

On granite or loamy surfaces, sweeping is omitted, fuel oil containing 60 to 70 per cent of 80 penetration asphalt being covered with windrowed material secured during the shaping of the base. The amount of oil required will vary from ½ to ¾ gal. per sq. yd. of surface treated. Previously-treated sections are scarified before oiling to insure maximum penetration.

The treatment described might be classed as a progressive mix rather than a dust palliative, as the cake developed after several years' treatment will satisfactorily sustain double its initial daily traffic of 500 vehicles. Benefits the first year, however, are more evident in lowered operating costs and added comfort to traffic than maintenance savings, due to a lack of uniformity in both base and penetration. Surface failures develop early and may be patched with a pre-mix of fuel oil and roadside material. When this becomes too extensive, the surface is lightly scarified and bladed back in place.

Pre-mixed material may be made by grading roadsides over a portion of the surface, applying 5 to 7 per cent of fuel oil by weight and mixing with a tractor grader, after which the material is windrowed at the side to be used as needed.

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Seasonal Planning.—In certain sections of the country it is advantageous to plan highway work so that work will not be in progress during the growing season of certain crops, in order to prevent damage caused by dusting over fruit or other products.

Evaluation of DISTANCE *and* TIME *in* HIGHWAY LOCATION

By N. W. DOUGHERTY
Professor of Civil Engineering, University of Tennessee, Knoxville, Tenn.

A critical examination of current estimates of the value of shorter highway routes—Effect of distance on operating costs—Value of saving time

ON practically every highway location, the engineer is forced to evaluate distance. He may not find his value in dollars and cents, but he is constantly balancing it against rise and fall, curvature and benefits to the community served. The problem is constantly before the highway engineering profession.

During the last few months, a number of articles have appeared showing the saving to be obtained by shortening distance on a highway location. Within eighteen months, at least two books which discuss the economics of highway locating have come from the press and both take the same attitude in regard to the savings which may be made by a change in distance. Often it is pointed out that Wellington's "Economic Theory of Railway Location" is very valuable for railway locating engineers but is not applicable to highway location. In making this statement, writers too often overlook Wellington's method of evaluating distance. In the following estimate, we have used Wellington's method and we believe that the results are closer to the actual savings than will be found by the commonly employed methods.

We are convinced that most estimates have been too sanguine and that the calculated savings ordinarily shown are much larger than any highway locating engineer may reasonably expect. The following may be very approximate for certain items but is certainly closer to the truth than most of the recent estimates that have been made. A recent published estimate of the cost of operating a motor vehicle per mile is given by the following table:

	Cents
Fuel	1.39
Lubricants	0.20
Tires	0.75
Maintenance	2.03
Depreciation	1.73
Garage	0.44
License	0.19
Taxes	0.01
Interest	0.53
Insurance	0.23
Total	7.50

Fuel.—Fuel consumption is probably more nearly proportional to distance than any other of the items in the list, and every driver knows that his consumption is increased when operating in the city over the consumption when operating on the open road. Stopping and starting require additional fuel. Driving in congested traffic requires additional fuel. On the open road, grades and high speeds add their quota to the consumption of fuel. If, therefore, the value given above is an average for all types of operation, no more than 70 per cent of this amount will be directly proportional distance.

Lubricants.—It is usually recommended that all vehicle operators have their oil changed after a certain traveled distance. If all car operators religiously followed the distance rule, they would still have to add oil on account of leaks in the mechanism and other losses. It is certain that other items than distance enter into the cost of oil. We therefore place the effect of distance as 70 per cent of the cost of oil.

Tires.—Usually, there is a minimum mileage guarantee on tires. This does not mean, however, that the wear and tear is necessarily proportional to distance. Operation on the open road during the summer time may cause more damage than the short-haul operation in the city during the same period of the year. The tires, being inflated at normal temperature, have an increase in pressure as they get hot under continued operation. In the winter time, the opposite condition may prevail. Stopping and starting may cause more wear and tear on the tires than the change of inflation due to the changes in temperature. It is observed that the type of road surface will have much to do with the wear on the tires. Again, if an automobile were equipped with perfectly new tires and allowed to stand in the garage for two years, there would be considerable depreciation in the last quality. We may, therefore, assume that not all of the wear and tear of tires is directly proportional to distance. The factor for distance will vary with the operator, the season of the year and the type of road. We therefore place the effect of distance as 60 per cent of the total cost of tires.

Maintenance.—Maintenance items depend upon distance but also depend upon the operator, the condition of the road and the average care of the vehicle. Any value listed as being proportional to distance will probably be subject to criticism. For our purpose, however, we place the effect of distance as 50 per cent of the cost of maintenance.

Depreciation.—At first thought, we are inclined to list a large depreciation factor but when passenger-car costs are analyzed we realize that a large part of the depreciation is actually obsolescence. As soon as a new model comes on the market, the old model has depreciated in value. Many dealers will look at the motor number to get trade-in value rather than look at the speedometer. From personal experience and observation of passenger cars owned by acquaintances, we place the depreciation factor as 40 per cent and fear that even this amount is high.

The other items, garage, license, taxes, interest and insurance, are not dependent upon distance. Insurance should depend upon the actual use of the automobile, but under present conditions it is proportional to the number of accidents rather than the number of miles.

Effect of Distances on Operating Costs.—We there-

fore construct a new table placing opposite the operating costs listed above, the percentage estimates just made giving us the effect of distances on operating costs:

	Cost Per Mile, Cents	Distance Factor, Per Cent	Cost Proportional to Distance, Cents
Fuel	1.39	70	0.973
Lubricants	0.20	70	0.140
Tires	0.75	60	0.450
Maintenance	2.03	50	1.015
Depreciation	1.73	40	0.692
Total			3.270 Cost

Many of the recent estimates have placed the savings as high as 10 ct. per vehicle-mile. This value is certainly very high and when used in estimating justifiable expenditures, the results are far above any amounts an engineer would be willing to recommend.

In a similar way, we may estimate the cost of distance for truck operation:

	Cost Per Mile, Cents	Distance Factor, Per Cent	Cost Proportional to Distance, Cents
Fuel	5.13	70	3.59
Lubricants	0.42	70	0.29
Tires	2.17	60	1.30
Maintenance	7.79	50	3.90
Depreciation	11.95	40	5.78
Total			14.86

Driver to be discussed under time losses.

Garage, license, interest, taxes, insurance and supervision do not depend upon distance.

In ordinary mixed travel, passenger cars and trucks are observed at varying frequencies. Assuming 10 per cent trucks and 90 per cent passenger cars we have a weighted average cost of

$$0.90 \times 3.47 = 2.943$$
$$0.10 \times 14.86 = 1.486$$
$$4.429 \text{ or } 4.43 \text{ ct. per vehicle-mile.}$$

The end of the story is not yet. Half the passenger travel, at least, is for pleasure and recreation. Any saving to this group is largely one of general conservation rather than one of special benefit to the road user. He may be on the road to travel distance and a saving in distance but defeats his purpose. Our conclusion is that we may reduce the saving below the 4.43 ct. computed above.

Application to Specific Problem.—Let us apply the results of our discussion to a problem:

"In locating a highway, there is a choice of two routes, one of which is 1 mile longer than the other; but on account of topographical conditions and land values, it is estimated that the cost of right-of-way and construction of the longer route will be $250,000 less than the shorter route. The maintenance cost is estimated to be the same for both routes. The annual traffic is estimated to be 150,000 vehicles, of which 10 per cent will be trucks, and the remainder passenger cars.

Considering the economy of operation of vehicles over the highway as well as the cost of the finished highway, which route should be selected?"

Our saving is 4.43 ct. per vehicle-mile, which capitalized at 5 per cent gives

$$\frac{\$150{,}000 \times 0.0443}{0.05} = \$132{,}900$$

A recent author solves this problem and estimates the justifiable expenditure at $365,000, with the conclusion "that the shorter route is economically preferable."

When we consider that 150,000 vehicles per year is only 411 per day, we doubt the conclusion that we can afford to spend $132,900 to avoid 1 mile of distance. Note that the above does not include loss of time.

The Loss-of-Time Question.—During the last few years, we have had many estimates on the value of saving time and they have ranged from ½ ct. per minute to approximately 2 ct. per minute. A recent book gives the following paragraph:

"As previously stated, it appears that one-third of the automobiles on the highways are used for commercial and two-thirds for non-commercial purposes. If the money value of 1.38 ct. per car-minute is used for the former and 0.75 ct. for the latter, the average money value of a car-minute for passenger cars is found to be 0.96 ct."

It will be noticed that the author places a value of ¾ ct. per minute on tourist and recreational travel. This estimate is but a reflection of the general attitude of the American people, at the present time. They are so intent in making savings in our industrial plants that they carry over the same ideas into our pleasure and recreation time.

If a person is driving upon the public highway for pleasure and recreation, he may be driving to spend time and no benefit will accrue to him if time is saved. A party may go on the highway for an afternoon's outing, planning to spend the afternoon. If the locating engineer has spent good money to decrease grades and shorten alignments, he may defeat the purposes of the party by carrying them to their destination in a short period of time rather than allowing them to spend the whole afternoon. This, of course, is an extreme case. The quotation above forgets that only about one-third of the day is spent in profitable endeavor. The rest of the day is spent in sleep and in recreation.

Some writers have been much distressed about the excess recreation time. They have led us to believe that if our leisure is not properly budgeted and supervised, we are in grave danger. It does not seem that any great loss occurs when a person who normally spends from 8:30 a. m. to 5:00 p. m. in the office is asked to leave home a few minutes earlier to make his office hours. The time thus lost is taken from his recreation time and is not working time.

During business hours, most estimates place the business travel at 33 per cent of the total travel. Instead, therefore, of listing ¾ ct. for the pleasure travel, this sum should be cut to zero. There is no doubt that a saving of time for business vehicles has a monetary value but there are cases, even in freight haulage, where the money value is very small. The hauler of freight usually makes a certain number of trips during a working day. If the time saved does not allow an extra trip, it is of very doubtful value. We therefore come to the conclusion that the monetary value placed on business time is high and that the monetary value on pleasure and recreation does not exist.

This item has a very important bearing upon the problem of evaluating grades and distance. We charge against distance the extra time involved in going the longer route. We charge against rise and fall a decrease in velocity due to the ascending grade and undertake to evaluate the time lost because of difference in speed. The estimates thus far published are far above any expenditure an engineer is willing to make. When we take into account the small value that time saving

may have, we arrive at conclusions more in keeping with our willingness to spend money.

Dr. McClintock, in the Kansas City traffic analysis, takes our attitude about non-business travel but adds an estimate of saving if all lost time had a money value. He explains that the estimate is of incidental interest and of little consequence, but his total reaches $268,000,000, while the real-estate value of Kansas City, Mo., is $354,000,000. No one would suggest that Kansas City should expend 75 per cent of her real-estate value to save traffic losses in the business district. This example is cited because we are convinced that time-loss estimates upon the open road have a similar exaggerated value.

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Motor-Vehicle Registrations and Fees in 1930

Registrations of passenger motor vehicles for 1930 showed a decrease from the 1929 figures, but motor truck registrations increased enough to make a slight gain of 0.08 per cent in total motor vehicle registrations for the year, according to reports of the 48 States and the District of Columbia to the Bureau of Public Roads, U. S. Department of Agriculture.

Registered automobiles, taxis and buses numbered 23,042,840 for the year, a decrease of 78,749 vehicles from the 1929 figures of 23,121,589; the registration of 3,480,939 motor trucks and road tractors showed a gain of 101,085 over the 1929 figures. The total registration of passenger vehicles and of motor trucks for the year amounted to 26,523,779, as against 26,501,443 in 1929.

The states and the District of Columbia collected in registration fees, licenses and miscellaneous taxes in 1930 a total of $355,704,860, which is $7,861,317 more than they collected in 1929. The revenue included fees on passenger cars and buses, on trucks and tractors and on trailers and motor cycles; also dealers' licenses, chauffeur and operator permits, and miscellaneous receipts.

In addition to passenger vehicle and motor truck registrations, 41 states reported a registration of 262,507 trailers, which is a gain of 69,463, or more than 36 per cent over the 1929 figures. This gain in trailers is the largest made in any one year as compared with a previous year since the bureau began to compile detailed registrations in 1921. The motorcycle registrations of the 48 States and the District for the year amounted to 107,811, a decrease of 7,034 from the previous year's figures.

New York and California, each report more than 2,000,000 passenger vehicles and motor trucks registered in 1930. Each of five states, Illinois, Michigan, Ohio, Pennsylvania and Texas, report more than 1,000,000 registered.

After deducting $19,196,926 for collection and administration expenses and $9,473,671 for miscellaneous items provided by various state laws from the total revenue collected of $355,704,860, the states apportioned the remainder to the construction and financing of state and local roads in the following amounts; $222,146,682 for state roads; $68,577,899 for local roads; and $36,309,682 was applied to state and county road bond indebtedness. Some of the purposes for which the miscellaneous funds were spent included refunds stipulated by law; state highway patrol; city streets; and general funds of cities and states.

The following table shows the 1930 passenger vehicle and motor truck registrations by states, the losses or gains as compared with the 1929 figures and the percentage of each, and the total revenue in fees, permits, etc., collected by the states:

MOTOR VEHICLE REGISTRATIONS AND FEES IN 1930

State	Passenger cars, taxies, and busses 1930	Motor trucks and road tractors 1930	Total gross receipts for 1930
Alabama	239,170	37,976	$ 3,799,761
Arizona	98,480	12,045	734,626
Arkansas	193,218	26,986	4,283,959
California	1,810,969	230,387	9,858,810
Colorado	276,847	31,662	1,901,230
Connecticut	279,830	51,196	8,290,404
Delaware	45,533	10,576	1,110,047
Florida	274,705	53,096	4,813,495
Georgia	294,461	47,119	4,482,257
Idaho	104,526	14,551	1,998,290
Illinois	1,430,676	207,584	18,444,247
Indiana	747,366	128,397	6,346,879
Iowa	706,196	72,190	12,693,621
Kansas	511,384	83,139	6,084,348
Kentucky	295,161	35,841	5,547,069
Louisiana	230,586	44,697	4,609,042
Maine	148,722	37,435	3,166,642
Maryland	283,870	37,832	3,437,796
Massachusetts	743,288	102,918	7,120,583
Michigan	1,161,051	167,158	22,482,412
Minnesota	624,902	108,070	11,062,150
Mississippi	203,443	33,651	3,046,393
Missouri	670,145	91,455	10,150,000
Montana	109,549	25,619	1,583,276
Nebraska	367,587	58,642	3,804,950
Nevada	23,388	6,257	373,966
New Hampshire	93,155	19,028	2,290,435
New Jersey	719,695	133,154	15,382,456
New Mexico	70,450	13,700	1,279,623
New York	1,966,981	340,749	40,857,715
North Carolina	397,133	56,108	6,835,743
North Dakota	155,383	27,636	1,958,662
Ohio	1,555,093	204,270	13,287,352
Oklahoma	490,947	59,384	6,535,361
Oregon	234,766	17,357	9,617,930
Pennsylvania	1,534,834	218,687	33,112,371
Rhode Island	116,792	19,631	2,280,849
South Carolina	192,141	26,261	2,878,352
South Dakota	180,195	24,977	2,959,913
Tennessee	330,436	37,823	4,767,239
Texas	1,159,139	206,757	13,961,362
Utah	96,128	17,869	855,584
Vermont	78,398	8,226	2,392,152
Virginia	318,582	57,307	6,493,989
Washington	382,874	63,188	7,616,676
West Virginia	225,900	40,373	4,702,812
Wisconsin	677,452	104,110	13,083,521
Wyoming	51,579	9,922	691,509
District of Columbia	139,733	16,943	636,001
Total	23,042,840	3,480,939	$355,704,860

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On Minnesota Concrete

State Trunk Highway Near LeSueur, Minn.—a 20-Ft. Concrete Pavement

There Are No Profits in Accidents

Carelessness Caused These Mishaps

A spill on a paving job not only delays the work but often results in the loss of valuable material

A careless "lift" cracks up a good dipper stick

Stalled on account of careless driving over soft ground

Over the end of the dump. Poor brakes and carelessness on the part of the dinkey runner wreck a work train on a grading job

Left—Careless dumping turns over a couple of cars. Besides the damage to the cars, the shovel was tied up until the cars were recovered. Right—A careless shot stops traffic on a double-track railroad for two hours

Left—Careless driving in hitting a high piece of rock in the grade and too short a turn to spill a load. Right—Careless backing pushes a truck over the bank and requires the time of two other trucks to get it out

EDITORIALS

Deficient Training in Fact-Gathering

THE average engineering college course calls for two years of pure mathematics. This sounds impressive, but let us see what it really amounts to. The editor averaged about 2 hours daily for 5 days a week studying his mathematics. The college year was about 36 weeks, so in two college years he totaled about 720 hours of mathematical study. This is equivalent to 90 days of 8 hours, or three months' continuous study on the analytical geometry and calculus that constituted the pure mathematics of the engineering course.

During the last four years the editor has spent the equivalent of 40 months of continuous work at 8 hours a day on research relating to weather cycles and allied problems. This is 13 times as much time as he spent learning "higher mathematics," yet no single subject received as much study during his four years at college as mathematics received.

This comparison serves two purposes. It shows how little time an engineering college student usually devotes to his most important subject, as compared with the time involved in a thorough study of some one physical problem that he may attack in after life. It also shows the superficiality of college training. From this it follows that it is ridiculous to claim that four years at college can impart even breadth of outlook, to say nothing of breadth of knowledge.

What, then, can be hoped that a college education may accomplish? Merely a training in efficient methods of acquiring knowledge and putting the acquired knowledge to use. Call it training in thinking if you please, but do not forget that it should be much more than that, namely, training in the securing of data with which to think. It is in this second part of the typical college course that the training is weakest. Let a lecturer talk till doomsday to the same class, and he will not have trained them in the gathering of facts. He will merely have told them facts, alleged facts and those explanations of facts called theories. The reading of the typical text book is no better in this respect. College laboratory work; if properly conducted, usually provides about the only training in personal search for facts; but usually the laboratory experiments are but a continuation of the lecture and text-book methods of imparting knowledge. In the laboratory the student makes measurements and tests the principles that have been imparted to him, seldom being required to search for and gather a large body of facts from which to draw his own inferences.

It is no more possible to train an engineer most effectively by such methods than to train a musician by merely lecturing to him. Fortunately, many engineers have enough resourcefulness and persistence to begin to train themselves as soon as they graduate. This they do by searching for useful information that they later apply in their work. But unfortunately they are in the minority. That they are in the minority is mainly attributable to the fact that in their entire 10 years or more of scholastic education, they received insufficient training in fact-gathering and fact interpretation. Those habit-forming years were not employed in forming the most important habit of all, namely the habit of "getting the facts." Purposeful fact-gathering has a way of forcing upon an intelligent man an attempt to understand the facts, and that is about all that there is to thinking. If there is any royal road to learning it is the road of fact-gathering. How many of us persistently travel that great highway?

W. P. Gillette

Chasing Rainbows

THAT another state contemplates turning all road work over to state highway authorities is evidenced by the following quotation: ". . . . if the change in our highway laws, placing rural highways under state control, takes place. In fact it is agitated in the legislature of our state now in session, that this be done and that the laws be amended so that the state highway department can build and improve earth roads." "If the legislature amends the laws to build cheaper types, and forces upon the department the rural highways, *a separate organization* and equipment *will have to be developed* to do the work *with the funds available.*" [The Italics are ours.—Editor.]

Where is the economy in such a step? The state can do no more than counties are doing themselves. Legislators are following a shadow, an apparition, when they follow the street talk of turning all roads over to the states. The quotation above, from a highway engineer in an eastern state, clearly shows that only a certain amount of work can be done and that is dependent upon the funds available. The cure for more improved county roads is not turning jurisdiction of them over to the state, it is not eliminating county administration, it is not merging counties; it is providing more funds with which the counties may work and thus enable those counties which have no technical supervision of road work expenditures to employ engineers, also to allow counties with meager funds to plan a progressive construction and maintenance program.

For the state highway departments as now constituted to act as consultants, in a consulting capacity is fine, but for jurisdiction of expenditures for county and lateral road work to be taken out of the hands of county authorities and placed in their hands is detrimental to the best interests of the counties, as well as being uneconomical.

Development of County Engineering

IN the field of public service, county engineering can be singled out as one activity that has passed through the most rapid stages of evolution. Twenty years ago this activity consisted of many duties of minor importance about the county such as the direction of convict labor work, tile or ditch drainage, land surveying, fence-line arbitration, road dragging, weed cutting and running a pile-bridge repair crew. Today so concentrated has the work or administration of secondary road construction and maintenance matters become that some of our best engineers are engaged in this service. The executive duties involved and funds handled are comparable to those of large commercial organizations. Development of road work necessitated by invention

and improvement of the automobile has been the motivating factor responsible for the greater opportunities afforded. County engineering now demands men of executive type, of large capacity, able to shoulder responsibility.

Road Administration, Construction and Budget

ADMINISTRATIVE policies essential to sound financing of construction and maintenance programs have been discussed with increasing intensity and volume both in this country and abroad, until we now have some definite conclusions of international significance, to which many nations will probably subscribe. These conclusions were proposed for acceptance by the International Chamber of Commerce in its recent session in Washington, D. C. The reports on which the conclusions are based were considered by 23 countries. The conclusions are as follows:

1. Road Administration

A. It is important to establish from the start a general plan of the road system, including existing roads and providing for their future development.

B. A rational classification of roads is desirable, taking into account the origin, destination, nature and density of traffic. Where a developed road system already exists a scientific traffic survey is the basis of this work.

C. Tendency in favor of financial and administrative centralization would seem to correspond to a necessity, at least as far as the main road system is concerned.

D. Autonomous governmental organizations for the administration and management of roads provided with separate budget are increasing in number, but their principle is still discussed in certain countries.

2. Road Construction

A. Before constructing or improving a road, it is necessary to make sure that its location and type are such as will attract sufficient traffic to justify the work. The first step is to get some sort of usable highway communication, thus making available at the earliest possible time a large mileage of roads, even though it be of a primitive character, in those countries which are at the outset of the work. This done the road can then be improved to the economic degree necessary to meet traffic requirements.

B. It is important to determine for several years in advance the program of the work to be undertaken.

C. The total of road-maintenance and vehicle-operation costs is reduced when a worn and ancient road is replaced by a modern surface of a type justified by the character and volume of traffic.

3. Road Budget

A. The crux of the problem is to apportion the cost of roads fairly between the three principal interests concerned—the general public, real-estate owners and road users. Roads are public property and it is logical that their cost should be met in part out of general revenue in proportion to the general public benefits. Real-estate owners in localities opened up by the roads should also participate to a certain extent in road expenditures, because of the special advantages they derive therefrom. Contributions from users are justified for the same reason, and with increasing use should assume a progressively larger share of the road budget.

B. Special taxes on highway users should be limited to such amounts as will not tend to deprive the public of the benefits of normal development of motor transportation. Such special taxes should be used exclusively for road purposes.

C. Loan issues based on reasonable general or real-estate taxes make it possible to gain several years in the construction of the road system of a new country. However, experience would seem to show that the bond method becomes more generally desirable when, with the development of traffic, it becomes practicable in increasing degree to base the loans on special taxes on road users. In any case, all maintenance costs should be met from current revenues. When a country has developed its road system to a high degree and has but little construction work to do, it should meet road construction expenditures out of current revenue when the latter suffices and have recourse to loans only in exceptional circumstances.

D. Experience has shown that a considerable portion—representing probably about half of the original cost—of properly constructed roads can continue to be used for a great many years and this fact may be taken into consideration in determining the program of amortization.

Test Roads

HIGHWAY engineers accept with caution statements by others on road-building materials and methods; they must perform their own experiments and they prefer the test road to the testing laboratory for judging results. The laboratory must continue to assist in designing and developing, but the real test is the serviceability of the road under traffic, weather and soil conditions.

Practical applications of theory by demonstration roads now include nearly every road-building material, and test roads may be found in nearly every state.

Demonstration roads are commonly laid as a part of the regular highway system and are service roads as well as test roads. They are not tested to destruction as were the Pittsburgh and Bates roads, but their reactions under local conditions are closely observed.

The problem of resurfacing and widening presents a most fertile field for demonstrations of this character because the engineer must decide whether he will resurface old roads with brick, plain concrete, reinforced concrete, hot bituminous mixtures or cold bituminous mixtures, and he must know how thick these surfaces should be.

The test road near Glenbournie, Md., built by the state roads commission and consisting of 14 different kinds of surfacing, is an excellent example of how to determine a suitable type for resurfacing outworn pavements.

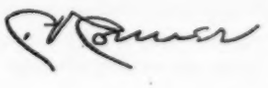
More experiments of this character are needed to help engineers in selecting types and producers of material in perfecting products.

Applied Research in the Road Field

TWO outstanding developments in research and their immediate and practical application to road construction and maintenance are found in the records of state highway activities during 1930.

The late Victor R. Burton and his associates in Michigan are credited with a real and practical application of soil science. Subgrades which have baffled maintenance engineers in that state for more than a decade, are now corrected by removing offending silt and replacing it by top soil found along the roadway.

The other application is the mud pump developed in Iowa. By its use depressed pavement slabs may be quickly, accurately and permanently brought to their proper elevation with little, if any, interruption to traffic and at a cost which more than justifies the operation. W. H. Root and his assistants in the Iowa Maintenance Department have thus demonstrated the most important aspect of research—its practical application.



County and Township Roads

What's Doing in the COUNTY ROAD FIELD

A resume of information collected and conclusions as given in papers and reports presented at the convention of the American Road Builders' Association

THE scope and interest of papers and reports presented by county officials and other leaders at the meeting of the County Highway Officials Division of the American Road Builders' Association during the 28th annual convention in St. Louis can be determined from the following abstracts:

State Aid for County Roads Increasing.—The rapid increase in state aid to counties during the past decade is an outstanding development in the financing of county highways. . . . Funds obtained from gas-tax and registration fees returned to counties have increased from $24,000,000 in 1924 to $122,000,000 in 1929 and state aid to counties is effective in 40 states. . . . Equitable financing of highways is based on the generally accepted principle that the user of the highway should pay for its construction and upkeep. Then state-aid funds should be a source of income on county highways carrying other than local traffic. . . . Unfortunately transportation surveys which include all mileage within the state have been lacking. Undoubtedly a large percentage of the county trunk mileage is being financed by local users which should receive funds from the general user. . . . As the state systems near completion, state aid to counties will continue to increase. The general adoption of engineering transportation surveys by all states, embracing the total highway mileage, can only result in a more rapid increase and an equitable means of financing county highways. It is important that county officials demand adequate representation on the transportation survey commission.—Committee on Legislation, Finance and Administration, Chairman Otto S. Hess, engineer-manager, County Road Commission, Kent County, Grand Rapids, Mich.

Illinois Counties Have State Support.—The operations of county organizations in Illinois in respect to planning, financing, accounting and standards of construction are closely coordinated with those of the state highway department. . . . Counties have been divided into three classes according to population; and a uniform basis has been outlined for development of connected state and county highway systems in each class. . . . The share of gas-tax funds allotted to each county in proportion to its automobile registration is established as a principal source of county highway income to supplement the county property tax. . . . Improvement programs of the counties must comply with fundamental requirements established by the state and deemed necessary to safeguard highway investments. Standards of construction are prescribed and a uniform system of auditing and accounting is established for all road and bridge expenditures. . . . The plan promises the same beneficial results in stimulating local initiative and improving construction standards and adminstrative methods of counties as have been brought about in state highway operation through federal aid.—Duncan Campbell, assistant county highway superintendent, Cook County, Chicago, Ill.

Financing Methods Improved in Illinois.—It is hardly possible to establish a uniform system of financing for 48 states and 3,000 counties with their varying degrees of highway completion, population, wealth and laws. Yet, if many of the unfavorable elements now existing are eliminated, financing methods will be greatly improved, much dissatisfaction will disappear and the building of a patchwork system of highways will be impossible. . . . One plan for financing counties described in the *Proceedings* of the American Road Builders' Association, classifies counties by population, sets aside a percentage of county roads, increases the gasoline tax award, allocates state aid half on vehicle registration and half on designated mileage with provision for local assessment, combines and budgets all county highway funds, accounts to the state for expenditures, requires state approval of plans, extends county aid on through city streets and provides for county maintenance.—B. C. McCurdy, county highway superintendent, St. Clair County, Belleville, Ill.

Allegheny County, Pa., Has a Master Plan.—Congestion of traffic can be relieved through distribution of traffic by rerouting and the building of boulevards and radial and belt-line highways. . . . Decision as to procedure should be determined by a comprehensive master plan. The value of such a plan extending over a period of years is firmly established. . . . In Allegheny County planned radial roads lead from Pittsburgh as a hub to suburban sections. Inner and outer belt highways that fit the rugged topography facilitate local traffic between adjacent outlying towns and by-pass through traffic, relieving congestion within the city. Points where routes converge within the city demand bridges, tunnels and grade separations. . . . Every regional or county plan must be flexible to fit the needs of a growing

community. Elbow room for future industries and population must be assured. The purpose of a plan is not to limit or restrict, but to guide and protect expanding development.—Committee on Regional Surveys and Plans, Chairman E. A. Griffith, chief engineer of roads, Allegheny County, Pittsburgh, Pa.

Plan So As to Improve Property Values.—Constructive planning involves investigation, analysis and interpretation of facts about population trends, automobile registration and gasoline consumption, the state of improvement of existing highways and parkways, highway traffic, taxation and wealth, climate, topography and geology. . . . Segregation of passenger and commercial vehicles as a result of opening parkways is highly desirable as a measure of traffic relief. The discharge capacity of a highway is increased as vehicles approach a uniform speed. . . . An improvement program proposed for immediate public endorsement must be possible of accomplishment within a reasonable time without burdensome taxation.—Geo. W. Farny, chairman, National County Roads Planning Commission, Morris Plains, N. J.

A Definite Plan for St. Louis County, Mo.—Legal adoption of a sound and practical master plan for St. Louis County, Mo., will commit future county boards to the fulfillment of the plan without major changes. The highway improvement programs of successive administrations will be directed toward a connected and economical system of county highways.—Roy Jablonsky, county engineer, St. Louis County, Clayton, Mo.

Centralized Control in Iowa.—Centralized control of secondary highways in each county avoids overlapping of duties, eliminates much duplication, reduces overhead, increases efficiency and admits of competent engineering direction. . . In Iowa, responsibility for the entire mileage of 96,000 miles outside of the state system formerly divided between 99 county and 1,609 township boards is now concentrated in the 99 county boards. . . .—J. C. McLean, county engineer, Woodbury County, Sioux City, Iowa.

Business Methods in Michigan.—The counties of every state should be required to establish adequate yet simple systems of accounting from which the detail costs of highway operation readily may be ascertained at all times. . . . In Michigan, records of costs are maintained, and efforts are being made to improve their usefulness in the interchange of data between various counties on a comparable basis.—A. R. Bailey, county engineer, Washtenaw County, Ann Arbor, Mich.

County Must Be Above Reproach.—In states where a large percentage of the rural road mileage is under township jurisdiction, economical progress on secondary systems requires a spirit of cooperation and friendly coordination of effort between the townships and the county. . . . These relations depend upon counties establishing practices beyond reproach which will demonstrate to taxpayers and township officials the benefits of competent supervision, and modern construction and maintenance methods.—L. J. Rothgery, field extension engineer, Michigan State College, East Lansing, Mich.

Successful Methods for Stage Construction of Low-Cost Roads and Bridges.—Low-cost roads and bridges are of especial interest to county highway officials. The progress in knowledge of successful low-cost practices has enabled a larger number of counties to undertake construction programs. Upon information now available, definite predictions can be made as to the serviceability of a variety of types under specific conditions. The report presents conclusions in four parts: finance, grading, surface and bridges. New methods of low-cost road construction are noted, but of greater significance is the much wider and more extensive use of established methods and types of equipment and refinements in their use and application. Heretofore low-cost bridges have been used on low-cost roads in many localities, but the report is probably the first effort to assemble information of them for general dissemination. Low-cost or progressive-type bridges in combination with low-cost roads reduce construction costs to the minimum.—Committee on Design and Construction, Chairman C. E. Burleson, county engineer, Pinellas County, Clearwater, Fla.

Widening and Reconstructing Recommendations.—Many states and counties either are engaged in or are about to begin a program of widening and reconstructing main lines of travel. Population in urban and suburban districts has grown at a rapid rate and a large percentage of the population has purchased motor vehicles. The improvement of tributary roads has enlarged the territories served by primary routes. Traffic has developed in increasing volume on all highways in the proximity of centers of population because of these facts. Provision of facilities for direct, prompt and safe traffic movement makes programs necessary for widening and reconstructing. . . . Interesting and complicated problems are presented for solution. The engineer is called upon to exercise more delicate judgment than in new construction because of the desire and urge to salvage as much as possible of the original investment. The report of the Committee on Design and Construction submitted a series of 22 conclusions on widening and reconstructing based on a survey of 14 states, 16 counties in 10 states and 6 regional planning commissions.—Committee on Design and Construction, Chairman C. E. Burleson, county engineer, Pinellas County, Clearwater, Fla.

Traffic-Bound-Road Maintenance.—Maintenance of any road should begin immediately following construction and be continuous. This is especially true in maintaining traffic-bound highway types. The principle of their construction, using successive light layers of road metal and depending upon traffic for consolidation makes it almost impossible to differentiate between construction and maintenance. . . . The report of the Committee on Maintenance, as to traffic-bound roads, assumes that the construction features of grading and drainage have been provided and that the road has not been developed to the stage of thickness and consolidation for a bituminous treatment. The report covers the phases of maintenance through the formative period intervening between initial construction and bituminous treatments. The quality of maintenance through this stage of development determines whether or not the road is a success or failure. . . .—Committee on Maintenance of Traffic Bound Roads, Chairman H. G. Sours, county engineer, Summit County, Akron, Ohio.

Planned Maintenance Essential.—Centralization of control in the county board for all rural highways not included in the state system justifies an adequate maintenance organization under competent engineering supervision. . . . Maintenance procedure should be founded on information collected about the size, shape and character of the area to be served and its traffic needs, the nature of existing roads and drainage structures, the maintenance equipment available, the resources at hand and the probable highway improvements which alter maintenance conditions. . . . The

system of maintenance should bring about a gradual improvement of the roads maintained. If traffic greatly exceeds the road capacity, maintenance costs are likely to be excessively high, and expenditures to change the road type to suit the traffic will be justified. . . . For efficient maintenance performance, definite work assignments are necessary as to area, roads, items of work, frequency of patrol and equipment. The work of the various crews should be balanced to insure full-time employment. Maintenance by contract is often satisfactory and economical for specific work. Its merits in any particular case should be investigated.—J. C. McLean, county engineer, Woodbury County, Sioux City, Iowa.

Scheduling Maintenance Operations.—Regular and systematic maintenance recognizes that there is a proper time for every maintenance operation. Prompt attention often saves heavy repairs and avoids the necessity of detouring or otherwise inconveniencing traffic. . . . For uniform results and maximum efficiency, maintenance operations should be controlled by explicit instruction as to details including execution of orders according to a fixed schedule.—A. M. Williams, county engineer, Ionia County, Ionia, Mich.

Welding Steel Highway Bridges.—Many steel and iron highway bridges which for economic reasons must remain in use under traffic greatly exceeding their original design capacities, can be strengthened at low costs by application of welding methods. . . . Without serious interference to traffic the value of critical connections, such as of floorbeams, knee-braces, and hip joints can be improved; top flanges of stringers restrained, stringers made continuous across successive supports, flange sections of floorbeams and stringers increased, buckling in eye-bars of lower end chords of pin-connected structures corrected, lateral bracing made effective, and deteriorated or weak sections rebuilt or replaced. . . . The large number of such structures under county jurisdictions where limited funds do not permit immediate replacements commends the report to the particular attention of engineers directing county operations.—Charles B. Dannenberg, bridge engineer, New Castle County, Wilmington, Del.

Public Confidence Follows Organization.—The individual public official should strive to merit the confidence of the public through prompt, efficient and courteous service, full publicity of his official work. He should regard the duty of advancing public welfare above all other obligations. A state organization of county officials will aid the officials of the individual counties in following sound administrative practices and will serve as a medium for effecting other desirable improvements in local government beyond the control of individual counties.—H. G. Culverhouse, president, Association of County Commissioners, Birmingham, Ala.

Organization Widens Knowledge.—State organization of county officials removes the handicap of limited influence and keeps all counties of a state abreast of the times by affording a medium for exchange of information about changing methods and practices. . . . Favorable legislation, comprehensive programs and uniform standards of design, construction and maintenance can be developed for a systematic plan of building that will erase radical differences in adjacent counties. . . . Active cooperation with state and other officials in outlining and sponsoring programs of mutual concern is developed.—J. W. Mavity, president, County Engineers Association, Newton, Kan.

South Dakota Organization Strong.—The State Association of County Commissioners of South Dakota has been the outstanding influence in crystallizing sentiment for good roads in South Dakota. This association has constantly advocated favorable legislation for highway progress. When federal aid was extended in 1916 contingent upon the existence of a state highway department, the county organization was carrying on its pioneer programs for better roads. It sponsored the bill for the creation of the state department and throughout the intervening years has worked in close cooperation with it in financing and developing the state system. —C. T. Charnock, secretary, County Commissioners Association, Sioux Falls, S. D.

Effective Organization Takes Time.—Sound ideals which will attract public interest and support for county programs can be attained only through organized effort over a period of years. Sacrifice of time is necessary by those having foresight to see future possibilities; they must strive for increased service and gradually higher standards on all county highway work. An organization founded on sound principles grows in public esteem as the good results of its operations become generally recognized.—Don Heaton, president, County Surveyors and County Engineers Association, Fowler, Ind.

Full Publicity Comes Through Many Agencies.—The technical magazines welcome articles on county methods and costs, news of county events, research work on county problems, information as to new equipment or equipment performance and activities of county highway leaders, associations, and societies. . . . Publicity in the technical magazine should be supplemented by county releases through educational bureaus, local newspapers, conventions, research activities, advertising, addresses, field contacts, radio speeches and cooperation with associations contacting the county field. . . . Full publicity through all agencies will contribute to the progress of county operations in advancing the knowledge and use of best practices and gain for county officials the confidence of their constituents.—Victor J. Brown, associate editor, ROADS AND STREETS, Chicago, Ill.

Planning Local Road Promotion.—The county highway problem is now in about the same stage of development as the state highway problem was 20 years ago. Experience in the movement to develop state highway systems is useful in local road problems. . . . Improved roads in constant use serving as examples and demonstrations for extension of their benefits give an advantage which was lacking when state programs were inaugurated. . . . The first step is the development of a definite plan which is possible of accomplishment within a reasonable period of time without burdensome taxation. This must be supported by wide publicity as to the value of hard roads, the local benefits to be derived and examples of other communities. It is of utmost importance that these be interpreted in terms of the individual. Each individual must be made to realize the personal advantages he will gain as a result of the proposed improvements. . . . A practical plan, wide publicity, active sponsors and a lively short promotional campaign are fundamentals for greater county progress. The initiative rests with the officials of the counties and states.—Roy Britton, president, Automobile Club of Missouri, St. Louis, Mo.

Rural Letter Carriers Promote Roads.—To further the cause of good roads, 40,000 rural letter carriers, through individual and committee studies, have ac-

quainted themselves with the technical and financial considerations necessary for successful and economic programs of road improvement. They recognize the benefits of competent supervision, careful and comprehensive planning and standard design, construction, and maintenance. . . . Leaders among them, serving as chairmen and members of good roads committees, are assisting in educating all citizens as to the returns of better roads for each individual, and the logic of respecting sound principles in all highway expenditures.—W. G. Armstrong, president, National Rural Letter Carriers' Association, Niles, Mich.

American Farm Bureau Action for Roads.—The future progress and prosperity of American agriculture absolutely depend upon more adequate transportation facilities starting at the farm gate. . . . The American Farm Bureau Federation is urging farm leaders everywhere to study the economic and social advantages of better farm-to-market roads for local application. . . . County committees are being organized to advocate and assist in the development of practical and comprehensive county highway plans. . . . An extensive educational campaign is under way to create favorable public opinion for increased county highway programs. This campaign merits the active support of all county highway officials.—Norman M. Blaney, director, Farm-to-Market Road Department, American Farm Bureau Federation, Chicago, Ill.

Low-Cost Roads *and* Single-Lane Pavements

By SAMUEL KNOPF

Principal Assistant Engineer, Delaware State Highway Department, Dover, Del.

Experiences in Delaware with premixed sand-asphalt, traffic-bound slag macadam, sand-clay and single-track concrete pavements

WHILE it is true that the larger proportion of the road funds available to date has been expended on the state systems, and the greatest amount of traffic is also handled over these roads, it is also true that unless consideration is given to the secondary and country roads representing 80 per cent of the total highway mileage, we have failed to solve the whole transportation problem. It is to this road which does not warrant higher types of pavements and upon which a low-cost surface will serve until traffic develops, that attention and study should be given if real adequate highway service is to be rendered. It is this problem, one primarily of financing, that will have to be met before we can truthfully say that the highway problem has been solved; to use money economically, and provide methods of construction to increase mileage and render satisfactory service and relieve large areas that probably will never have hard-surfaced roads.

In road building, cost depends chiefly on the type of pavement, and the selection of the type is the most important task the engineer has to perform; and it is the one in which we have made the most serious blunders. It is quite possible that in designing our type of roads we have been influenced too much by public clamor. The public wants wide, high-type, smooth roads so that they can ride in comfort and at high speed. They are not interested in the economics of transportation or in costs. To date we have supplied their wish. Rural communities now educated to the value of improved roads are demanding better road service in their own communities. Their desire is to be able to reach their markets at all times of the year as readily as their city neighbor and they want to be able to carry the same sizes of loads at all seasons of the year. Have we failed economically to stretch the dollar by not classifying our roads according to their prospective traffic and earning capacity? After all, building highways is a business prosposition and highway transportation sooner or later must be conducted on a business basis.

Selection of Type.—It is plain that the difference in cost of operation under identical conditions over different pavements is the saving effected by one pavement over the other; and the annual cost of any pavement is the interest on cost of construction, plus the average annual maintenance, plus an annuity which, set aside each year, will restore the surface of the road when worn out. The annual earning power of a certain pavement would be the saving per vehicle-mile times the number of vehicles per day during the year.

The selection of type of pavement should be based on these data plus the effect of the character of traffic and the availability of local material. When these have been determined, the roadway should be selected which will be susceptible of later improvement without an appreciable loss of the original investment. By this method a large mileage of low-cost roads can be put into use, creating more traffic and income, and as these increase, the pavement can be improved progressively.

Conditions in Delaware.—The state of Delaware several years ago completed its primary road system connecting each city, town and village. Of a total of rural highways estimated at 4,000 miles today the state's system comprises 820 miles or better than 20 percent of the rural highways. In addition the counties' hard-surface roads amount to about 250 miles more, so it is estimated that our system will accommodate practically 90 per cent of the traffic. Yet there still remains 75 per cent of the rural highways unimproved, with many mud-bound communities without an outlet to an improved road. This mileage must be built and improved at a low capital outlay per mile in order to bring proportionate returns in traffic service.

With the farming sections clamoring for roads and

a growing sentiment in favor of the building of low-cost roads, the department three years ago in cooperation with the bureau of public roads made a soil survey of available material, especially in the lower counties.

We are not as fortunate as the remainder of the north Atlantic states in regard to local road-building material. Maryland, New York, New Jersey, Pennsylvania and the New England states have rather abundant distribution of glacial gravel and stone, which make satisfactory road-building materials for low-cost roads at a reasonable expenditure.

Our surveys indicated that most of the soils were a loamy silt formation with no inherent qualities for compaction or wear; there were some stretches of sandy soils and a few small limited areas of poor gravel. Unfortunately no soils were found to exist in large stretches that could be made into first-class low-cost earth roads without some additional material—either sand, clay or stone—to act as a stabilizer.

Types of Low-Cost Roads Built in Delaware.—The first attempts to build cheaper roads were on the sandy stretches. The type used here was pre-mixed sand-asphalt, similar in construction to those of North Carolina—a progressive development of the type of road around Cape Cod, Mass.

Three years ago we built 20 miles of this type by contract at a cost of construction only 16 per cent cheaper than a concrete road of similar width and thickness. No doubt a cheaper sand-asphalt road could have been built if the method of construction had consisted of shaping the road with a road grader and applying oil by means of distributors and harrowing until a good mixture was obtained.

Another type of which 30 miles has been built the last three years is that of traffic-bound slag roads, a type of low-cost road popular in Ohio, Kentucky, Virginia, and West Virgina, which is really a subgrade stabilizer and road surfacing combined. This consists of using small-sized crushed slag or stone at the rate of about 700 to 1,000 tons per mile on the subgrade and periodically blading so as to maintain a thin, loose layer of stone on the surface. This type is easily and quickly constructed and traffic after the grading operation may use the road at once. These roads are machined three times a week and, due to this dragging operation, ride smoothly up to speeds of 40 to 59 m.p.h.

Over the sand-loam and clay-soil areas the department has maintained to date about 20 miles of earth roads, adding sand or clay to the soils in order to obtain best results.

It is only on these sand-clay roads that the department has used its own maintenance forces for construction and has built these roads at a reasonable cost; other types have been built by contract. The low and intermediate-cost roads that have been built have been of an experimental nature to fit the type of pavement to the conditions to be met, the idea being to observe them over a period of years without the state loading up on equipment to carry this type of work.

The One-Lane Cement Highway.—Relative to one-lane concrete roads, we have always believed that this road has its proper place in our highway system. Our state, with the exception of the area around Wilmington, is purely agricultural. With no local available material, aggregates for any kind of road have to be imported into the state and a one-lane concrete pavement requires a minimum of material. The roadways in these areas carry relatively light traffic of a local nature but with a proportionate amount of truck traffic for a large part of the year. The farmer is primarily interested in getting his produce to market and he wants to haul full loads of legal limit any day he sees fit. This requirement had to be met. Another factor was to build a road of low maintenance cost, so that when the widening time arrived the original investment would still be preserved. Calculations based on all considerations indicated to us that genuine maximum economy lay in the building of a single-lane high-type surface of cement concrete. We believe we have been justified by the building of nearly 80 miles of this type during the past four years and believe that over a period of years, taking into consideration first cost and maintenance and the cost of the operation of motor vehicles, this type of pavement will be cheaper than the lower-type pavements.

Delaware's maintenance cost on single-lane concrete roads averages about $95 per mile, which includes all work between right-of-way lines such as cutting grass and weeds three times a year. These pavements are built on the same typical section of a 20-ft. concrete pavement, the only exception being that the single lane is placed to one side of the center-line.

The building of single-track concrete roads is not a new development. They have been built since 1913 and are giving good service. Their general use extends to 21 states of the union in over 120 counties and to date over 2,000 miles of this type has been built.

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Urge County Manager

A movement to create the office of county manager is continually gaining ground in Warren County, Va., and gives promise of becoming a major issue in the next county election. Inspired by the efficient administration of public business in the county seat, Front Royal, under the direction of Lester B. Dutrow, town manager, leaders in the county-manager movement are determined to place a manager in charge of county affairs.

"If Front Royal can be governed so well under a town manager, why can not Warren County gain the same advantages with a county manager?" is the question asked by the Warren *Sentinel*, county weekly newspaper. Increased efficiency and less costly government would be gained under the county manager plan, it is claimed by proponents of this system.

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Half-Width at a Time

A One-Lane Concrete Road in Cameron County, Tex.

BEFORE and AFTER Pictures of Earth-Road Grading Operations

Experimental construction in cooperation with the University of Kansas on the Lawrence-Baldwin road in Douglas County, Kan.

BEFORE grading operations were begun

FIRST STEP—Widening curve by cutting down bank

NEXT CUT on curve cuts and moves

LAST CUT cleans out ditch

AFTER completion of grading on the Lawrence-Baldwin road

County roads improved with traffic-bound surfaces constructed of washed gravel; extension will be made to entire system.

BEFORE and AFTER Graveling Logan County, Ill., Highway System

BEFORE—Primm Road south of Lincoln, Ill., before improvement with county funds

AFTER—Primm Road after application of gravel surfacing. Note rounded corner

The Road Builders' News

Road Builders' Annual Meeting Plans New and Broader Activities

Expansion of cooperative work with other organizations to develop an enlarged and continuing program for road and street construction was the keynote of the annual meeting of the American Road Builders' Association in Washington on May 14 to 16.

The program included meetings of the executive committee and the board of directors of the association and similar meetings of the City and County Divisions. Forty organizations interested in the development of roads and streets were represented at the annual dinner given this year in honor of W. A. Van Duzer, the retiring president, recently named traffic director of the District of Columbia. W. R. Smith, President, Lane Construction Corporation, Meriden, Conn., was installed as president at the same dinner together with the other newly elected officers.

Two Types of Members Proposed.—The report of the ways and means committee of the Manufacturers' Division approved at the January meeting was adopted by the board of directors of the association. This report provides a plan by which manufacturers who exhibit at the Road Show are grouped as sustaining and transient members. Sustaining members have special rights as to service from the association, special "member rates" for space at the Road Show together with priority in the assignment of space, and membership fees are deductible from charges for space at the Road Show. Transient members pay regular rates and are exhibitors only. The membership of the Manufacturers' Division is now being canvassed.

Cooperative work now in progress between the American Road Builders' Association and the Association of State Highway Officials, the U. S. Department of Commerce, the Associated General Contractors, the Highway Research Board and other organizations was approved and provision made for expansion of its scope at the annual meeting of the board. Resolutions of appreciation and regret were adopted on the death of Samuel Hill and V. R. Burton.

Advance Planning for Public Works Recommended.—The County Highway Officials' Division recommended the nation wide planning of all public works several years in advance as one of the most important methods of alleviating unemployment in times of depression. Activities for the coming year include studies of uniform county planning with standard enabling acts for districts, methods of state aid extension to counties, a manual for county planning, specification forms, methods of promoting county bond issues, widening and reconstruction and aerial photography for planning.

The City Officials' division outlined the committee work for the coming year in five committees: design and construction, pavement financing, maintenance, traffic and airports. A. D. Butler, City Engineer, Spokane, Wash. and A. H. Moore, City Engineer, Indianapolis, Ind., were appointed directors.

The 1932 Convention and Road Show will be held in Detroit, Cleveland, or Philadelphia according to recommendations of the executive committee of the Manufacturers' Division. The board of directors approved the holding of the 1932 Road Show and left the selection of the city to the discretion of the executive committee of the association.

Activities of Association Outlined.—The annual report of Chas. M. Upham, Secretary and Engineer-Director of the association, stated that the past year had been especially active within the association and all activities had been centered toward standardization of materials, equipment and methods, and the continuation and increase of highway programs—city, county and state.

The activities of the past year including exhibitions of large scope at the American Fair in Atlantic City and the International Road Congress in Washington. Student memberships drawn from representative engineering colleges have been successfully inaugurated. Activities of the various divisions operated in the interests of counties, cities and states have expanded. Pan-American and European division activities have been developed through honorary representatives.

"While the country suffered a general industrial depression during the past year, this has not, in any way, affected the progress and development of the American Road Builders' Association," the report stated. "The Association is now engaged in more activities than formerly and is carrying on joint work with more associations than at any time previously. The activities of the various committees conducted by the staff engineers are becoming in even greater demand by city, county and state officials, as well as manufacturers of equipment and producers of material.

"The Road Show held in January, 1931, was a complete success and outstanding in many details from former shows. It was well attended and the exhibit representing the show window of the industry was indicative of the great development that had been brought about in construction and maintenance machinery and equipment during the past year.

"The committee activities and outline of reports as set forth in the annual Blue Book show that during the past year there were 37 major committees, with a large number of subcommittees. The chairmanship of these committees was held by the outstanding engineers and officials located in different parts of the country and associated with city, county and state highway work. The chairmen for the various committees were selected as men of authority on the respective subjects. The reports that were prepared during the past year served as a basis for the annual convention program and were well received and appreciated, as has been evidenced by the great demand for copies of these reports.

"Because the reports were so great in number and comprehensive in content, a slight variation has been made in the preparation of the annual *Proceedings.* This year the *Proceedings* will contain a summary of each report including an analysis, conclusions and recommendations of the subjects treated.

Bulletins to Be Issued.—"Full reports will be published in bulletins issued from time to time during the year. These bulletins will be of great value. The fact that they can be obtained at a minimum of expense makes it possible to give them a wide distribution, reaching engineers and officials who never receive copies of the *Proceedings.* Another great ad-

vantage may be obtained through the receipt of these bulletins members of the Association will keep constantly in touch with the activities of the organization."

New Studies to Be Started.—The program and committee activities for the coming year, the report continued, include the continuation of some of the studies previously started and the initiation of other studies and details in connection with highway work. A part of this work will include joint activities with the American Association of State Highway Officials, Associated General Contractors of America, Highway Research Board, United States Department of Commerce, National County Highways Planning Commission and other similar organizations.

Nearly 400 at President's Dinner.—The representative gathering of leaders in road and street activities included 386 people at the president's dinner. The Bureau of Public Roads' representation included Thos. H. MacDonald, chief of the bureau, and the chiefs of most of the executive divisions. The Department of Commerce, the Forest Service, the U. S. Engineers department and the Bureau of Efficiency were well represented. There were 14 foreign diplomats, 25 District of Columbia officials of high rank. Fifty manufacturers of road and street machinery and materials were present. There were 56 officers and directors in attendance—leaders in road and street activities.

Thos. H. MacDonald, chief of the Bureau of Public Roads, told about the standardization of specifications of road construction and methods brought about throughout the country with the assistance of the bureau. He explained how pavements are injured by hard rubber tires of vehicles and discussed the present lack of uniform traffic regulation. He recommended that traffic regulation should not be limited by state, county or city lines.

Contractor Installed as President.—W. R. Smith, who was installed as president, is head of the Lane Construction Corporation, Meriden, Conn., a road building organization that has built thousands of miles of highways throughout New England and is now working in seven states.

Close cooperation between the American Road Builders' Association and the many other organizations working for the good of roads and streets was emphasized by Mr. Smith in his address. He cited examples of such broad cooperation without duplication of effort and for mutual interests in expanding highway programs.

He explained the scope of the organization and its international aspects by introducing the heads of the various divisions. The Manufacturers' Division is headed by W. T. Chevalier, Publishing Director of the McGraw-Hill company, New York; City Officials' Division by G. B. Sowers, Commissioner of Engineering and Construction, Cleveland; County Highway Officials' Division by Otto Hess, Engineer-Manager, Kent county, Grand Rapids, Mich. He called attention to the Pan-American activities of that division headed by Senor M. A. Coroalles, chief engineer of the Cuban Central Highway and the Cuba Department of Public Works, and the American delegation present at the opening of the Cuban Central Highway. Maj. G. W. Farney, director of the European division, has brought about contacts with many European countries.

"Many cities are clamoring for the next road show and convention that assembles 25,000 road builders," he said. "The Michigan legislature has passed and presented a resolution signed by the governor and the heads of both houses asking that the meeting be held in a city of that state. The great difficulty is to find exhibition buildings large enough to house this largest assemblage of machinery held in the world and few American cities can qualify."

Mr. Smith paid tribute to the enterprise and skill of Chas. Upham, engineer-director of the association, in steering the research, exhibitions and highway promotional work of the association.

President's Dinner, American Road Builders' Association, Willard Hotel, Washington, D. C., May 15, 1931

New Equipment and Materials

New Aluminum Straight Edge

A new aluminum straight edge has just been put on the market by The Cleveland Formgrader Co., West 116th Street and Nickel Plate R. R., Cleveland, O. The particular features of this improved straight edge are that it comprises a box section with flat bottom for checking the pavement surface together with a double thick web and hemmed top for strength

Aluminum Straight Edge

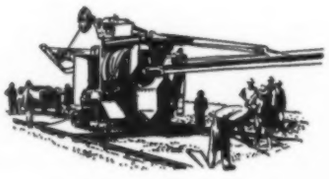
and stiffness. Because of its ingenious design, it is claimed to be possible to obtain greater strength in this straight edge blade with a weight of only 4 lb.

Other advantages claimed for this new straight edge are that it employs an aluminum handle which is lighter but at the same time stiffer than wood and, also, the braces which assist in holding the straight edge blade to the handle are of aluminum for further lightness. The straight edge blade is 10 ft. in length, which complies with the majority of specifications of the different Highway Departments.

Semi-Crawler Tracks

Semi-crawler tracks adaptable to the McCormick-Deering 10-20, Case Model "C," Allis-Chalmers Model "U," and the Fordson tractors have been placed in production by the Peerless Track Co., St. Joseph, Mich. These tracks are the rigid rail type. Each shoe is fastened together by two pins. When these pins show signs of wear, all that is necessary to do, is take the pin out, turn it around ¼ of a turn and put it back in place. Thus the same pin can be used four times. The same thing is true with the entire track unit. For instance, when the right hand track is beginning to show wear on the sprockets and shoes after a period of years, this right unit can be taken off the right hand side and placed on the left hand side of the tractor, and the left hand unit placed on the right hand side, thus completely reversing the wear of the tracks.

Peerless Tracks on Trackson



The tracks are a full oscillating type. Each track is free to oscillate independently of the other track, and the fender is secured to the individual track, which makes the fender oscillate with the track.

Boring Machine for Installing Small Diameter Pipe

A boring machine designed expressly for installing corrugated iron drain pipe in 8, 12 and 18 in. diameters without halting traffic has been developed by the Armco Culvert Manufacturers Association, Middletown. O.

Armco Boring Machine in Operation

The Armco boring machine serves the double function of excavating and removing the material replaced by the pipe. The entire machine is mounted on a track upon which it is moved forward as jacking progresses. The jacking itself is done by hand at the rear of the machine by means of an especially designed jack operating on a rack between the rails of the track on which the machine moves. Power for excavating is provided by a gasoline motor and is transmitted to the "borer" by a shaft extending through the pipe. A spiral conveyor is built around this shaft, which, as it revolves, removes the spoil through the pipe upon a smooth metal trough placed in the invert. When a section of pipe has been placed, the machine is returned to the starting point, another section of pipe and a corresponding length of lining and conveyor attached, and the process repeated. This is continued until the required amount of pipe is placed.

New Bucyrus-Erie Introduced

A new 37-B, a 1¼ to 1½-yd. shovel-dragline-crane-clamshell, has been announced by Bucyrus-Erie Co. With a choice of Diesel, gasoline, or electric power; rope or chain crowd on the shovel; regular or special extra long and wide mountings for soft ground work on the dragline, the 37-B fits well the various requirements of the field.

New Bucyrus-Erie 37-B

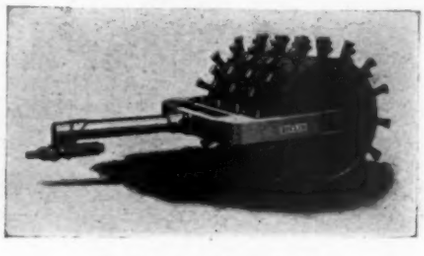
The machine has Bucyrus-Erie steels and unit steel construction, ball bearings on all continuously running shafts, large over-size clutches, gears enclosed and running in oil, box girder boom, and single-shaft-drive caterpillar mounting.

A few other features of interest are: hoist clutches power set—all operating levers toggle in; smooth operating, over-size brakes with cooling fins; steered from operator's stand with cab in any position; double-operating checking brakes on caterpillar mountings—controlled from operator's seat; swing brake for operating on grades; three side vision for operator—steel cab; inserted tooth dipper; only two bearings to a shaft—no binding of bearings; power dipper trip; self starter for engines; power boom hoist—self locking.

New Euclid Tamping Rollers

The latest development of the Euclid Crane & Hoist Co. is the Euclid Single and Twin Tamping Roller. This is an improved design of the commonly known sheep's foot type of roller and features an oscillating action which permits the roller to conform to the contour of the ground.

In construction the characteristic Euclid Drawbar is used, giving greater strength. Both the single and twin tamping rollers are attached to the tractor by the original Euclid drawbar spring-mounted clevis thus eliminating a rigid direct jerk when starting and relieving both tractor and equipment of excessive strain.



Euclid Tamping Roller

Improve YOUR SAND-GRAVEL ROADS!

COLD ASPHALT ROAD EMULSIONS used as the binder will PERMANENTLY IMPROVE a sand-gravel road surface

This Virginia road was surface treated in **1930** *using a typical road oil*
(O. C. 5)

The adjoining section of the same Virginia road surface treated at the same time using COLAS
(A. E. 3)

COLAS (REG. TRADE MARK)

IS AN EMULSION OF PURE STRAIGHT RUN ASPHALT AND WATER

BUILDS DURABLE LOW-COST ROADS

FIRST COST IS BUT LITTLE MORE PER SQUARE YARD—ULTIMATE COST PER SQUARE YARD IS MUCH LESS

Because

- permanent results.
- maintenance eliminated.
- superior riding surface.
- superior binding qualities.
- waterproof, non-skid surface.

Full particulars and literature sent on request

COLAS ROADS INC.

PERSHING SQUARE BUILDING
NEW YORK

New Orleans Cincinnati *Boston* *Chicago* Atlanta Dallas

When writing to advertisers please mention ROADS AND STREETS—Thank You

Distributor News

Boyer, Veteran in Cement Industry, Retires

A man whose career in the cement industry dates back to the time of the first concrete pavement in America, has announced his retirement. This veteran in the industry is Edward D. Boyer, a director of the American Society for Testing Materials, and for many years a member of the Portland Cement Association's technical problems committee. He is now retiring as technical service manager of the New York office of the Universal Atlas Cement Company, a subsidiary of the United States Steel Corporation.

Mr. Boyer entered the cement industry back in 1888, as superintendent of a mill at Cementon, Pa., when only a few straggling American cement mills dared to compete with the product imported from Europe. He has seen American cement shipments grow from a few thousand barrels a year in the eighties to 160 million today, with producing capacity for 100 million more.

A native of Catasauqua, Pennsylvania, in the now famous cement producing Lehigh valley, Mr. Boyer specialized in chemistry at Muhlenberg College, Allentown, and graduated from the Philadelphia College of Pharmacy as president of the class of more than 400 members, in 1877.

A few miles from his home and college communities, David O. Saylor had established in 1872 at Copley the first American cement plant. It was this plant which first attracted Mr. Boyer's attention. Twenty years later the first concrete pavement was laid at Bellefontaine, Ohio, and is said to be still in service.

Displacement of the old dump kilns by the new rotary kilns, which are long cylinders often large enough to drive an automobile through, forced the company employing Mr. Boyer to dissolve, and in 1900 he went to Elizabeth, Pa., to build a rotary plant. This was never operated, however, because the patented process of manufacture proved unsuccessful, and he joined the Atlas Portland Cement Company in 1902 as assistant to the general superintendent of the Northampton plant. In 1914 he went to New York as technical department manager of this organization which later became a subsidiary of the United States Steel Corporation through its union with the Universal company in 1930.

During the world war Mr. Boyer was chairman of the Portland Cement Association's committee on concrete ship construction, assisting in the construction of several concrete vessels for the United States shipping board. He is 73 years of age, lives at 55 East 10th Street, New York, and is a member of the Engineer's, New York City, and Westchester Hills Golf clubs.

E. K. Borchard, technical service engineer, also of New York, who joined the Atlas organization in 1917, succeeded to the position vacated by Mr. Boyer. Mr. Borchard represented the shipping board during the construction of the concrete ship "Faith" at San Francisco in 1918 and also aided in building other concrete ships and barges.

Edward D. Boyer

New Western Representative for Young Radiator Co.

W. H. Benduhn has been appointed representative for the Young Radiator Company for the Pacific Coast district to handle the sale of their products such as engine coolers for gasoline, oil and Diesel engines, air compressors, drag lines, trucks, power units, etc.

The western offices of this company are located at 664 Mission Street, San Francisco, where complete technical information will be kept on file for ready reference to the clientele served.

The Young company manufactures a special type of tubular radiator for industrial purposes, said to be practically immune from clogging, which on account of alkaline conditions prevailing in the west is thought to be of particular interest to the Pacific coast trade. This situation was taken into consideration in the design of the radiator which is offered by Mr. Benduhn in a number of types and varieties.

Change in Name

Effective May 1st, the company name of Flintkote Roads, Inc., was changed to Colas Roads, Inc. It is said that the new name is thought to be more descriptive of the products of the company. No changes in personnel have been announced.

Large Construction Company Adds to Truck Fleet

The Consumers Company of Chicago, one of the largest dealers in the country in building materials, and said to be for many years operators of the largest fleet of heavy duty dump trucks in Chicago, is adding to its fleet. The company has just contracted for the purchase of twelve new type trucks from the Autocar Company of Ardmore, Pa. The order, calling for immediate delivery, is regarded as an indication of improvement in the construction industry.

F. H. Burr on Southern Business Trip

The director of the automotive division of the Cleveland Pneumatic Tool Company, F. H. Burr, is making a survey of the southern and southeastern parts of the United States in the interest of his company which manufactures Cleco Gruss air springs for buses and trucks and other pneumatic-operated machinery and accessories for the automotive field.

Mr. Burr expects to be away for several weeks, visiting dealers and distributors in Charlotte, N. C., Orlando and Jacksonville, Fla., Birmingham, Ala., Memphis, Tenn., Lexington Ky., and Cincinnati, Ohio.

Riddell Sounds Optimistic Note

The *Great Warco Spirit,* the cheerful little booster for the personnel and products of the W. A. Riddell Company of Bucyrus, Ohio, reports increased sales shown by fourteen of their distributors during the month of April, with bright prospects for continued progress throughout the month of May. The *Spirit* states: "The general conditions are most assuredly improving, and with the gain in general conditions, mental attitudes everywhere will improve, so that before we realize what has happened, we will be sailing along on calm, smooth waters.

Schramm Announces Winners

The contest for sales of air compressors, conducted as an air race, mileage being recorded according to volume of sales, reached its final goal, with the winner of the first prize the General Supply and Equipment Company of Baltimore, directed by Henry C. Ripple. Others to whom grand total prizes were awarded were: 2nd, Smith-Booth-Usher Company, Los Angeles; 3rd, Harris Pump & Supply Co., of Pittsburgh; 4th, Richmond Machinery & Equipment Co., Richmond, Va.; 5th, Polleys Equipment Company, Providence, R. I.

Prize winners for the mileage during the month of April were: 1st, Baltimore; 2nd, Providence; 3rd, Cleveland; 4th, So. California; 5th, Richmond.

Interaco News, published in the interest of better street and highway paving, in a recent issue predicted that one of the major developments in highway construction during the next decade must come along the line of the development of safety surfaces.

- Longest life—40 years not uncommon . . . . .
- Lowest maintenance is proved by records . .
- For both light and heavy traffic . . . . . .
- Preferred on street car lines . . . . . .
- Easily opened and closed for service cuts . . .

Busy Streets *need* VITRIFIED BRICK PAVEMENT

WHERE heavy traffic flows, there you need brick. It keeps the lanes open year after year for less cost than any other pavement known.

And for busy roads, brick is the logical choice, for both new construction and resurfacing old slabs. Brick *resists weather,* arch-enemy of most pavements. The material is so tough and dense that nothing on wheels can damage it. Thus, more use at less cost.

For additional information, Address National Paving Brick Manufacturers Association, 1245 National Press Building, Washington, D. C.

Above: Looking down a 40-block stretch of Brick pavement on Richmond, Virginia's East Main Street, of which city Colonel R. Keith Compton is Director of Public Works; Mr. A. Mason Harris is Chief of the Bureau of Streets. *To Right:* Close-up of brick surface from Connecticut Ave., Experimental Road, Chevy Chase, Md., which was built over 17 years ago by the U. S. Bureau of Public Roads. In this test Brick has the lowest maintenance cost of all pavement types.

VITRIFIED BRICK PAVEMENTS

FACE THE FUTURE « » PAVE WITH BRICK

Whitcomb Company Becomes Division of Baldwin

According to recent announcement, there has been a reorganization of the Geo. D. Whitcomb Company of Rochelle, Ill., which has become a division of the Baldwin Locomotive Works, with Baldwin executives as directing officials. It is stated that the Rochelle company will be known as the Whitcomb Locomotive Company and will operate as a self-contained unit. This company has been experimenting for the past 24 years in the industrial locomotive field.

George H. Houston, president of the Baldwin Locomotive Works, will head the list of executives as president of the Whitcomb company. The other officers are as follows: John P. Sykes, senior vice-president of Baldwin, first vice-president; H. H. Perry, former vice-president of the Industrial Brownhoist Corporation, vice-president and general manager; H. V. Huleguard, sales manager; Charles E. Acker, treasurer of Baldwin, treasurer; and Arthur L. Church, secretary of Baldwin, secretary.

It is said that original policies established by the Geo. D. Whitcomb Company will be continued under the new management with whatever changes are advisable to increase the efficiency of the products and service.

Buda Company Passes Half Century Mark

1931 marks the golden anniversary year for The Buda Company of Harvey, Ill., manufacturers of gasoline and Diesel engines used for equipping many products for the highway, industrial and water works fields.

Established in 1881 at Buda, Ill., this company started in a modest way as manufacturers of railroad supplies. At the end of the first decade the factory was moved to its present location at Harvey, a suburb of Chicago, affording excellent facilities for a growing industry. Its story is one of consistent growth and today its employees number approximately 1500 and the shops occupy 500,000 sq. ft. of floor space. Its working capital is said to be upwards of $7,000,000, and its products are used throughout the world.

While still maintaining its leadership as a manufacturer of railroad supplies, which it established during its early years, this company early recognized the possibilities opening up in the automotive field and in 1910 brought out a line of high quality gas and gasoline engines for trucks, buses, marine, industrial and other purposes.

In 1926 the company began the manufacture of the Buda M. A. N. Diesel engines and a large new factory building with new equipment throughout was provided for this purpose. Its plant is served directly by the Illinois Central, Baltimore and Ohio and Grand Trunk Railway Systems.

The official personnel of the company is as follows: L. M. Viles, president; F. E. Place, vice-president and general manager; H. M. Sloan, vice-president and general sales manager; J. S. Dempsey, secretary and treasurer; E. D. Conant, vice-president and general superintendent; R. B. Fisher, vice-president in charge of railroad division; G. B. Wright, sales manager automotive and marine division; R. K. Mangan, sales manager, industrial division.

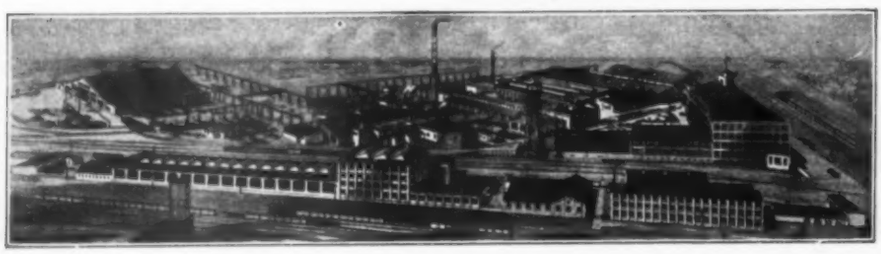
R. F. Mehl Joins Armco Research Department

R. F. Mehl, superintendent of the division of physical metallury of the Naval Research Laboratory has been appointed assistant director of research of the American Rolling Mill Company, Middletown, Ohio. He will be in charge of the physical science department of the Armco laboratories, and will take up his new responsibilities September 1st. He has been one of the research consultants for this company for the past eighteen months.

R. F. Mehl

Mehl received his B. S. degree at Franklin and Marshall College in 1919; remaining for the time being in university work he was successively research assistant in the department of chemistry at Princeton University from 1920-22; Procter Fellow in Chemistry at Princeton, 1923; Ph. D. in chemistry in 1924 at Princeton; professor of chemistry and head of that department at Juniata College in 1923-25; National Research Fellow at Harvard University 1925-27; and since September, 1927, superintendent of the physical metallurgy division of the Naval Research Laboratories at Washington, D. C.

As the author of numerous papers Mehl's work has attracted considerable attention. The subjects upon which he has written are: Preparation of pure alloys, aluminum-magnesium alloys, vacuum apparatus, refractories, compressibility of alloys, compressibility of tellurium, crystal structure and constitution of cadmium-mercury alloys, interatomic forces and cohesion in metals and alloys, crystal structure of the alpha copper-tin alloys and several papers on the Widmanstatten structures in alloys, and radiography by the use of the gamma rays. He is also the translator of Professor Tammann's "States of Aggregation" by D. Van Nostrand, 1925.



Factory of The Buda Company at Harvey, Ill.

Buffalo Council Pays Tribute to Fisk

Geo. F. Fisk, formerly commissioner of public works, Buffalo, N. Y., recently retired from public office to engage in the private practice of consulting engineer.

Because of Mr. Fisk's long and faithful service, and for his ability and achievements accomplished, bringing distinction to himself and credit to the city, a formal resolution was passed by the city council and presented to Mr. Fisk, expressing to him its high regard of his professional ability and extending best wishes for his success in his new field of work.

Mr. Fisk has served the city of Buffalo for 25 years, and his achievements include several important and arduous engineering projects and public improvements of great magnitude. He has opened offices at 557 Ellicott Square, Buffalo, for the practice of consulting engineering, with especial reference to paving and municipal problems.

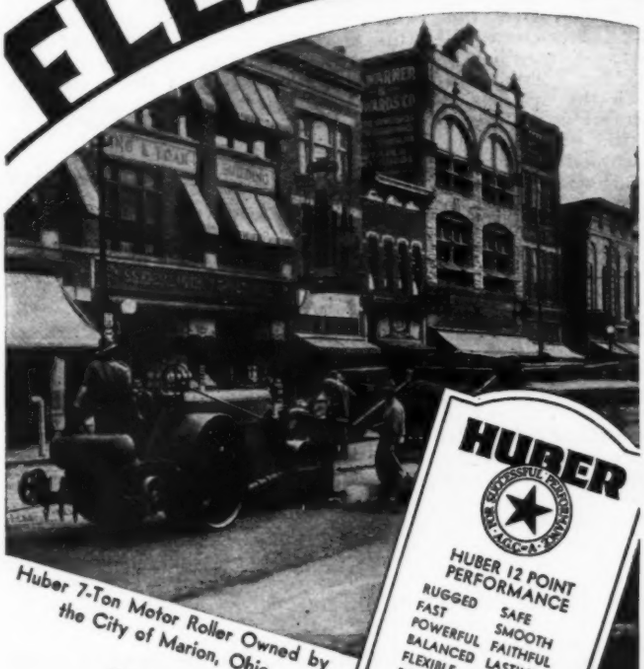
Schramm Changes Address in New York

Schramm, Inc., whose headquarters are located at West Chester, Pa., have moved their New York office from 54 Dey Street to 90 West Street. The change will afford more spacious showroom and storage facilities, and a complete stock of compressors, tools, accessories and repair parts will be maintained at the new location for the inspection of their friends and patrons.

An efficient and trained service department will be ready to respond to calls, and convenient parking space has been provided for patrons calling at the new office. Telephone numbers are unchanged, Cortlandt 7-0879 and 7-2769.

Chicago Pneumatic Tool Company, 8 East 44th Street, New York City, announces the election of W. L. Lewis as executive vice-president in a statement made through the president of the company, H. A. Jackson. Mr. Lewis, who for the past year has been vice-president in charge of finance for this company, was formerly assistant comptroller of the Bethlehem Steel Corporation.

FLEXIBLE



HUBER

HUBER 12 POINT PERFORMANCE

RUGGED SAFE
FAST SMOOTH
POWERFUL FAITHFUL
BALANCED LASTING
FLEXIBLE ACCURATE
PROFITABLE PRACTICAL

Huber 7-Ton Motor Roller Owned by the City of Marion, Ohio.

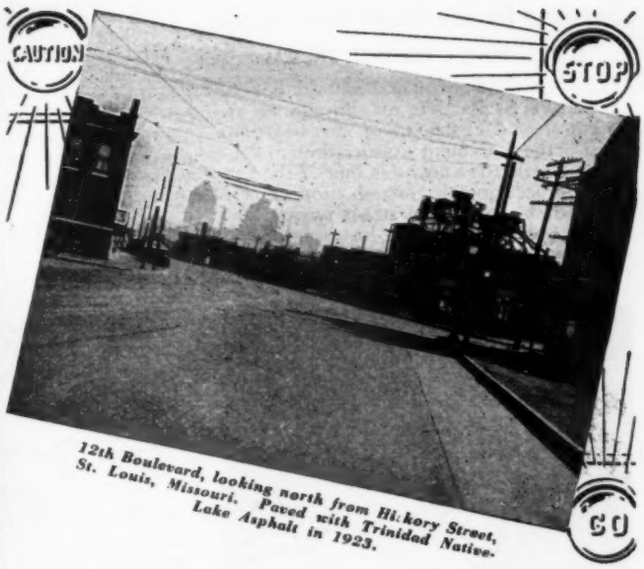
REGARDLESS OF THE TYPE OF ROAD JOB

THERE is a Huber Motor Roller to fit every highway construction and maintenance job. Abundant power for the hard pulls...a wide range of road speeds...ruggedly constructed to stand all the punishment you will give it. Built from 5 to 14 tons. Write for New Huber Motor Catalog.

THE HUBER MFG. CO. • MARION, O.

355 E. Center Street

HUBER MOTOR ROLLERS



12th Boulevard, looking north from Hickory Street, St. Louis, Missouri. Paved with Trinidad Native-Lake Asphalt in 1923.

Heaviest traffic street in St. Louis paved with Trinidad

Three powerful forces — traffic, time and weather test the wearing qualities and endurance of a paving material. St. Louis will testify —as will thousands of cities throughout the world—that Trinidad makes good on all three tests.

That's because Trinidad gets its durability and its tenacity from *Nature*. Centuries of seasoning gives Trinidad its unique ability to withstand the ravages of wear and weather—as well as a resiliency which absorbs shock, lessens noise and makes it easy to clean and economical to keep in repair.

For Road Building—we recommend another Native-Lake product—Bermudez Road Asphalt. Write for proof of its worthiness.

THE BARBER ASPHALT COMPANY

PHILADELPHIA

New York Chicago St. Louis Kansas City San Francisco

TRINIDAD NATIVE LAKE ASPHALT

Bartlett Made Staff Executive Portland Cement Assn.

The appointment has been announced of George S. Bartlett of Chicago as assistant to the chairman of the board of the Portland Cement Association.

Mr. Bartlett is known as one of the pioneers in securing the introduction of concrete for highway and street paving, and for the past twenty years has been closely identified with the good roads movement. He has been an important figure in the

George S. Bartlett

activities of the Portland Cement Association almost since its inception.

He has a wide acquaintance in the cement and related industries and has served in an executive capacity with several of the earliest cement companies. For the past sixteen years he has been with the Universal Atlas Cement Comuany as a special representative. Under the 70 year retirement rule of the United States Steel Corporation, of which the Universal is a subsidiary. Mr. Bartlett was recently retired.

His many old friends will be glad to learn that he has joined the forces of the Portland Cement Association and will be located at headquarters, 33 West Grand Avenue, Chicago.

▾

Westinghouse Promotes J. M. Lessells

John M. Lessells, formerly manager of the mechanics division of the Westinghouse research laboratories, has been appointed manager of engineering in the South Philadelphia works of the company, to succeed A. D. Hunt, resigned, it has been announced by R. S. Feicht, director of engineering. The appointment became effective May 1.

Entering the Westinghouse organization in February, 1920, he spent six months in the office of the chief mechanical engineer. He then held the position of mechanical engineer in the railway department until May, 1922, when he became associated with the research department.

Appreciating the value of research in the field of mechanics, he began building up the division of which he later became the head.

Mr. Lessells is a member of the Institution of Mechanical Engineers, London, and a member of the American Society of Mechanical Engineers, being secretary of the executive committee of the applied mechanics division of this society. A member of the American Society for Testing Materials, he belongs to the special research committee on fatigue of metals and is chairman of the group on impact testing. He also holds memberships in the Iron and Steel Institute, London; the Society of Automotive Engineers, and the American Society for Steel Testing. He is a member of The Edgewood Country Club, Pittsburgh.

▾

Linn Elected Official of Export Club

William J. Linn, export manager of the Cleveland Pneumatic Tool Company and the Cleveland Rock Drill Company, manufacturers of pneumatic tools, machinery and accessories for the automotive, aeronautical, oil, mining and other industries, has been made vice-president of the Cleveland Export Club.

The election took place at the recent annual meeting of the club, at which a number of important subjects were discussed according to an announcement by the foreign trade department of the Cleveland Chamber of Commerce.

▾

AC Spark Plug on Full Time Basis

According to a recent report the A. C. Spark Plug Company of Flint, Mich., is now operating on a full time

H. C. Curtice, president A. C. Spark Plug Co.

employment basis, consisting of nine hours daily, five and a half days a week.

The president of the company, Harlow G. Curtice, stated that the return to full time is a reflection of increased production schedules of those manufacturers to whom AC supplies equipment, and of new business acquired during the past few months. Mr. Curtice declared that April equipment orders from manufacturers have not only shown an increase over March, but compare favorably with April of 1930.

"Operations at this time of year," he said, "are usually around the peak, and this increased activity compared with the winter months, is quite natural. However, the extent of the present increase and the fact that it calls for full time employment is gratifying."

▾

N.I.A.A. Plans Constructive Sessions for June Meeting

The National Industrial Advertisers Association will hold their ninth conference at The New Yorker in New York City, June 15th to 17th, inclusive. This conference offers to the industrial advertiser an opportunity to hear what some of America's leading industrialists have to say regarding present and future business.

Mr. Allan Brown, first vice-president of the Association, makes the following statement: "The N. I. A. A. Conference in June at the New Yorker is to be, in a sense, a clinic. We are going to vivisect Present Business Conditions to find the source of its ills. If your sales are below normal, if you have any selling problems at all, you cannot afford to miss this conference!"

▾

Blaw-Knox to Handle Ateco Products

According to a recent announcement the Blaw-Knox Company has acquired the exclusive sales and manufacturing rights of the Ateco line of earth moving machinery from the American Tractor and Equipment Company of Oakland, Cal., for the United States east of the Rocky Mountains and for all other countries.

The line includes hydraulically operated earth movers, bulldozers, scarifiers, tamping rollers and combination outfits.

▾

The National Scaleman's Association has elected C. C. Neale, of the Toledo Scale Company as president of the association. Mr. Neale has been connected with the scale industry for over forty years and is conversant with world weighing practices. He was the first president of the first scalemen's association in the United States, which he aided in founding.

▾

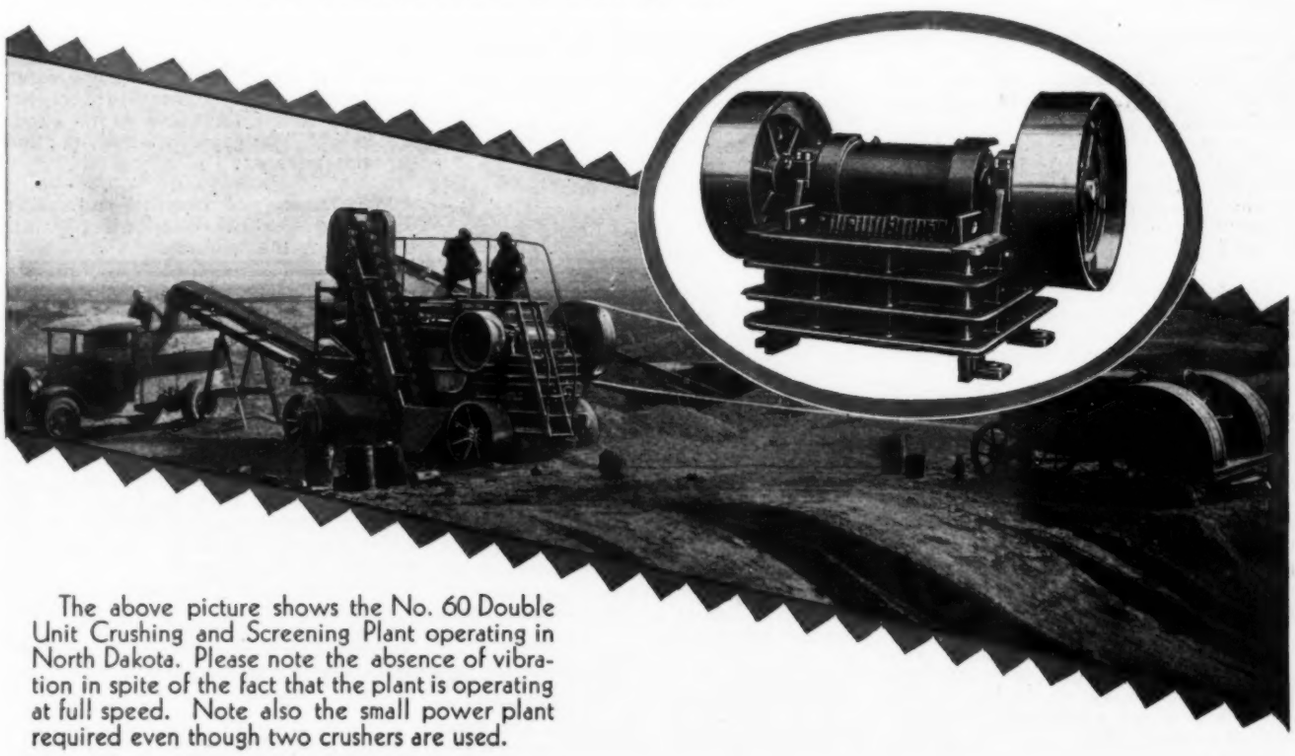
Westinghouse Electric and Manufacturing Company recently elected the following officers: A. W. Robertson, chairman of board; F. A. Merrick, president; J. S. Tritle, vice-president in charge of manufacturing; S. M. Kintner, vice-president in charge of engineering; L. A. Osborne, H. P. Davis, H. D. Shute, J. S. Bennett, H. T. Herr, Walter Cary, T. P. Gaylord and Harold Smith, vice-presidents. C. H. Terry was elected an honorary vice-president and E. M. Herr was reelected vice-chairman.

▾

Russell Manufacturing Company, Middletown, Conn., manufacturers of brake lining and other automotive fabric products, announces the appointment of the following jobbers to handle their complete line: J. W. Butts, 198 Church Street, Poughkeepsie, N. Y.; Genuine Auto Parts, 410 Washington St., Utica, N. Y.; L. E. Pin, 22 Railroad Street, Holyoke, Mass.

There is a DIAMOND for every job

Diamond Portable Crushing and Screening Plants and Crushing Plants are all equipped with Diamond Timken Roller Bearing Jaw Crushers and made in all sizes to meet the demands of every job. All vital parts are equipped with roller and ball bearings and the framing is electrically welded, giving extreme rigidity and eliminating the replacement of rivets which have become loose or sheared off.



The above picture shows the No. 60 Double Unit Crushing and Screening Plant operating in North Dakota. Please note the absence of vibration in spite of the fact that the plant is operating at full speed. Note also the small power plant required even though two crushers are used.

Diamond Iron Works, Inc.

MINNEAPOLIS, MINN. U.S.A.

Yes—We would like you to mention ROADS AND STREETS

Service Exchange
for Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives of their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Sales engineer, experienced in earth-moving machinery, desires connection on salary or salary and commission basis. Wide acquaintance with machinery dealers, oil and gas industry, pipe-line contractors and material men. References.

Warehouse facilities for serving Pittsburgh territory. Would like to secure line of portable and stationary conveyors.

Wanted, agency for any type of building specialties or contractors' machinery except mixers. Twenty years' experience. Familiar with all types of contractors' machinery. Could act as sales manager for Atlantic coast line with dealers.

Distributor covering Wisconsin and Illinois territory wishes to add to present lines. Thoroughly familiar with bituminous materials and equipment for handling.

Distributor situated in Portland, Oregon, desires line of stationary diesel engines, from 75 to 150 hp., to serve western trade for driving rock crushers and industrial plants.

Wanted, line of street markers or other traffic equipment on exclusive basis by distributor covering New Jersey and New York territory.

Distributor situated in Virginia wishes to make connection to represent manufacturer of manganese crushing plates and jaw rock crushers.

Export manager for American manufacturer of road graders is in a position to handle an additional line of non-competing construction machinery, for manufacturer seeking foreign representation.

Manufacturer's representative situated in New York City, now handling pumping machinery, would like to take on two or three additional lines serving the same field as his present account.

Manufacturer's representative with 25 years' sales experience, conversant with all types of pumps and their field, desires agency for either New York or export territory or both.

Wanted, exclusive sales right for state of Mississippi for line of automatic or self-loading wheeled scraper.

Wanted, for Buffalo, Niagara frontier and western New York territory, a good power and heating boiler account.

Wanted, line of picks, sledges and crow bars, spades, shovels and similar implements by New Jersey broker, with warehouse facilities, contacting New York and New Jersey jobbers.

Representative in northwest desires to handle on commission basis line of road building and maintenance machinery, revolving scarpers, tractors, rotary snow plows and V-type push plows.

Manufacturer's representative, covering Massachusetts, Rhode Island and southern New Hampshire, would like to secure line of speed reducers and gears.

Equipment distributor in Pacific northwest desires line of road-building equipment, structural building equipment, dump bodies and truck hoists.

Distributor of building specialties covering territory of 100-mile radius from Chicago is equipped to represent additional lines.

▼

Representatives Wanted

Manufacturer of a new tractor dump wagon has a number of desirable territories open. Full cooperation extended to distributors.

Manufacturers of ditching and trenching machines, to facilitate the laying of pipe lines has liberal proposition to offer dealers.

Manufacturer of metal traffic lane markers for pavements, has a number of desirable territories open. Write for their proposition.

Manufacturer of air compressors and contractors' tools has number of desirable territories open. Full cooperation will be extended to distributors.

Long established and well-known manufacturer of industrial locomotives wishes to make contacts with qualified distributors. Locomotive line includes steam, gasoline, gas-electric and oil-electric. Supported by national trade journal advertising.

Manufacturer of complete line street repair equipment, tar kettles, heaters, patching plants, torches, etc., has open territory in southeastern states and desires active distribution. Territory largely open from Virginia to gulf states, inclusive, also state of Oklahoma.

Eastern manufacturer of grade-rippers, scrapers and road hones has desirable territory open for distributors.

Distributor with large warehouse, show room and service facilities, desires two or three additional lines. Maintains large sales organization, covering New York, Vermont, Maine, Massachusetts and Connecticut.

Manufacturer of asphalt ingredient adaptable for use in the road or industrial field, is seeking representatives for desirable territory in various parts of the country.

California territory available for distributor wishing paving expansion joint account.

Good, unassigned territory available for distributors and manufacturer's representatives to handle paving expansion joint line.

Manufacturer of transverse testing machines desires to build up distribution organization in this country and abroad.

Several desirable states open. Wanted, distributing organizations covering entire states by manufacturer of mechanical spreader.

Territory open in several states for representatives to handle grade-rippers, mechanical plows.

Manufacturer of steel dump bodies and oil heaters seeking distribution points in west central and southern states, including Missouri, Kansas, Iowa, Nebraska, Colorado, Kentucky, Tennessee, Mississippi, Arkansas, Louisiana and western half of Illinois.

Attractive territory open in states south and west of Chicago by manufacturer of cut-to-length, easily-erected standardized steel highway bridges, for spans up to and including 40 ft. Product sells to highway commissioners and superintendents.

Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Manufacturer of contractors and builders levels and transits is seeking district sales manager. Exclusive contract given. Excellent territory still available. Backed by national advertising.

Manufacturer of complete line of construction equipment, mixers, saw rigs, plaster and mortar mixers and pumps has an open territory in the state of Maine and is looking for an aggressive distributor to represent him there.

Manufacturer of patented luminous highway danger signs and signals is interested in securing aggressive representation in various parts of this country and Canada.

One of the leading manufacturers of surveying instruments in the United States is seeking responsible agents in all sections of the country. Instruments are nationally advertised in all leading engineering journals.

Manufacturer of patented highway and zone marking machine desires sales representatives who are acquainted with highway officials in their own state.

Manufacturer of special corrosion-preventing lubricant for road machinery and construction equipment wishes to establish distributing points throughout the country.